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# Nutrient Content of Native Grasses on Sandy and Red Sandy Loam Range Sites in South Texas

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# Nutrient Content of Native Grasses on Sandy and Red Sandy Loam Range Sites in South Texas

By J. H. Everitt, M. A. Alaniz, A. H. Gerbermann, and H. W. Gausman<sup>1</sup>

## ABSTRACT

The effects of season and precipitation on the crude protein, phosphorus, calcium, magnesium, sodium, and potassium contents of native range grasses from sandy and red sandy loam range sites in south Texas were determined and these data were used to determine the critical periods of protein and mineral deficiency in beef cattle. Grasses were sampled monthly from September 1975 to August 1977; 15 grasses from the sandy site and 6 from the red sandy loam site. Livestock grazing the grasses from either site would probably need supplemental feeding of protein and K from December through February or early March. Year-round supplemental feeding of P, Mg, and Na would be recommended on both sites. Index terms: beef cattle, calcium, crude protein, phosphorus, potassium, magnesium, native grasses, nutrient content, rainfall, red sandy loam range, sandy range, seasons, sodium, supplemental feeding, Texas.

## INTRODUCTION

Two of the major range sites of south Texas are the sandy range site and the red sandy loam range site (fig. 1). The sandy site comprises over 700,000 ha and the red sandy loam site nearly 470,000 ha (Godfrey et al. 1973). Both sites are primarily used as native range. On the red sandy loam site, the brush is sometimes controlled and the range is reseeded to buffelgrass (*Cenchrus ciliaris* L.) (Everitt and Cuellar 1976).

Cattle that graze native grasslands select their diet from plants whose nutrient content is always changing (Wallace et al. 1972). For ranchers to plan for optimal use of range forage and supplements, they must know the nutritive value of range grasses throughout the year; yet there is little information

on the nutrient content of native grasses on these range sites. Our objectives were: (1) to measure seasonal differences in crude protein (CP) and minerals in 15 grasses growing on a sandy site and 6 on a red sandy loam site, (2) to determine the relation of rainfall to the amounts of CP and minerals in the grasses, and (3) to determine the periods of critical deficiency of protein and minerals for range cattle.

## STUDY AREA

We conducted this study on the McAllen Ranch, about 40 km northwest of Edinburg, Tex., in Hidalgo County (fig. 1), where the climate is mild; winters are short and temperatures are relatively warm throughout the year (annual mean of 24° C). The average growing season exceeds 325 days (U.S. National Oceanic and Atmospheric Administration 1976). Summer temperatures and evaporation rates are high. Average annual rainfall is 49 cm; the lowest average rainfall occurs in January and Feb-

<sup>1</sup>Range scientist, biological technician, soil scientist, and plant physiologist, Science and Education Administration, U.S. Department of Agriculture, P.O. Box 267, Weslaco, Tex. 78596.

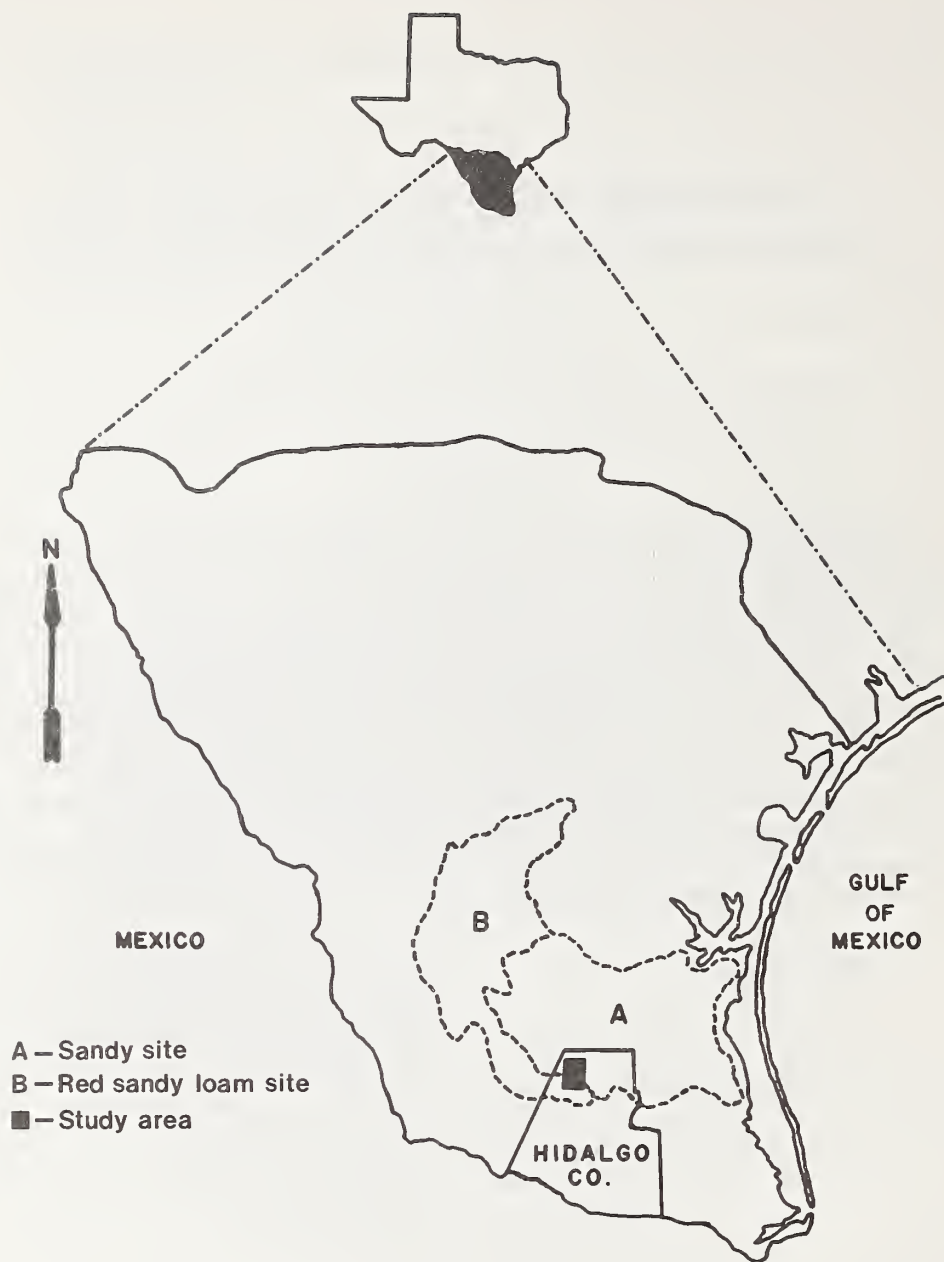


FIGURE 1. — Study area in Hidalgo County in the sandy and red sandy loam range sites of south Texas.

ruary and the highest in May and September. Long rainless periods are common any time of the year. The topography is flat to gently sloping.

Two major range sites are found on the study area, one associated with sandy soil and the other with red sandy loam soil. The sites occupy large uniform areas; the southern part of the ranch consists of red sandy loam range and the northern part of sandy range (fig. 1). The sandy site is asso-

ciated with the Nueces-Sarita soils complex; the Nueces series is a member of the loamy, mixed hyperthermic family of Aquic Arenic Palenstalfs, and the Sarita series is a member of the loamy mixed hyperthermic family of Grossarentic Palenstalfs. The red sandy loam site is associated with the Delmita-Randado soils complex; the Delmita series is a member of the fine-loamy, mixed hyperthermic family of Petrocalcic Palenstalfs, and the



FIGURE 2. — Sandy range site.

Table 1. — Average annual production of herbaceous vegetation on the sandy range site

Major species	Production (kg/ha)	Composition (% by weight)
Roemer threeawn.....	382	33.3
Fringed signalgrass.....	149	13.0
Sandbur.....	94	8.2
Knotgrass.....	67	5.8
Fringeleaf paspalum.....	48	4.2
Hooded windmillgrass.....	35	3.1
Red lovegrass.....	14	1.2
Miscellaneous grasses.....	61	5.3
Forbs.....	296	25.9
Total.....	1,146	100.0

Randado series is a member of the loamy, mixed, hyperthermic, shallow family of Petrocalcic Ustollic Paleargids.

Both the sandy site (fig. 2) and red sandy loam site (fig. 3) are relatively open, with a mixture of brush, grasses, and forbs. Mesquite (*Prosopis glandulosa* Torr.) is the dominant woody species on the sandy site. The red sandy loam site is dominated by a variety of woody plants including blackbrush (*Acacia rigidula* Benth.), bluewood (*Condalia hookeri* M. C. Johnst.), lime pricklyash [*Zanthoxylum fagara* (L.) Sarg.], and mesquite. Pricklypear (*Opuntia lindheimeri* Engelm.) is found on both sites.

The sandy site is dominated by several species



FIGURE 3. — Red sandy loam range site.

Table 2. — Average annual production of herbaceous vegetation on the red sandy loam range site

Major species	Production (kg/ha)	Composition (% by weight)
Red lovegrass.....	137	17.5
Hooded windmillgrass.....	129	16.5
Roemer threeawn.....	122	15.6
Fringed signalgrass.....	88	11.3
Slender grama.....	82	10.5
Sandbur.....	49	6.3
Miscellaneous grasses.....	35	4.5
Forbs.....	140	17.8
Total.....	782	100.0

of short grasses (table 1) including fringed signalgrass [*Brachiaria ciliatissima* (Buckl.) Chase], fringeleaf paspalum (*Paspalum setaceum* Michx.), hooded windmillgrass (*Chloris cucullata* Bisch.), knotgrass [*Setaria firmula* (Hitchc. & Chase) Pilger], red lovegrass [*Eragrostis oxylepis* (Torr.) Torr.], Roemer threeawn (*Aristida roemeriana* Scheele), sandbur (*Cenchrus incertus* M. A. Curtis), and slender grama [*Bouteloua repens* (H.B.K.) Scribn. & Merr.]. Several species of mid and tall grasses also occur, but they comprise only a small percentage of the species composition. The red sandy loam site is dominated by six short grasses (table 2), fringed signalgrass, hooded windmill-

grass, red lovegrass, Roemer threeawn, sandbur, and slender grama. A variety of forbs are found on both sites.

Most land on the McAllen Ranch is used for cattle ranching (primarily the cow-calf operation), using a continuous grazing system with one animal unit per 10 ha. The same grazing system is used on both range sites.

## METHODS

Fifteen native range grasses from the sandy range site and six from the red sandy loam range site were sampled monthly from September 1975 to August 1977. The 15 grasses from the sandy site included 8 short and 7 mid and tall grasses. The eight short grasses were fringed signalgrass, fringeleaf paspalum, hairy grama (*Bouteloua hirsuta* Lag.), hooded windmillgrass, knotgrass, red lovegrass, Roemer threeawn, and sandbur. The seven mid and tall grasses were balsamscale (*Elyonurus tripsacoides* Willd.), brownseed paspalum (*Paspalum plicatulum* Michx.), crinkle-awn [*Trachypogon secundus* (Presl.) Scribn.], seacoast bluestem [*Schizachyrium scoparium* (Michx.) Nash var. *littoralis* (Nash) Gould], switchgrass (*Panicum virgatum* L.), tanglehead [*Heteropogon contortus* (L.) R. & S.], and Texas grass [*Vaseyochloa multinervosa* (Vasey) Hitchc.]. On this site crinkle-awn, seacoast bluestem, switchgrass, tanglehead, and Texas grass are decreasers (plant species of the original or climax vegetation that will decrease in relative amount with continued overuse); brownseed paspalum, fringeleaf paspalum, hairy grama, hooded windmillgrass, and knotgrass are increasers (plant species of the original vegetation that increase in relative amount, at least for a time, under overuse); and balsamscale, fringed signalgrass, red lovegrass, Roemer threeawn, and sandbur are invaders (plant species that were absent or present in very small amounts in undisturbed portions of the original vegetation of a specific range site and will invade following disturbance or continued overuse). Many of these grasses comprised only a small percentage or trace of the species composition on the study site, but were considered important because they are abundant on other sandy sites.

The six grass species sampled from the red sandy loam site, all short grasses, were fringed signalgrass, hooded windmillgrass, red lovegrass, Roemer threeawn, sandbur, and slender grama. On this site slender grama is a decreaser, hooded

windmillgrass is an increaser, and fringed signalgrass, red lovegrass, Roemer threeawn, and sandbur are invaders.

Ten or more plants (both leaves and stems) of each species were collected and pooled on one day at the end of each collection month. (The phenology of the various grasses on each sampling date is given in tables 3-5.) Plants were collected from the same general area each month. They were clipped 3 cm above ground, air-dried at 65° C for 48 hours, ground in a Wiley mill through a 1-mm-mesh screen, thoroughly mixed, and stored in sealed jars.

Samples were pooled and analyzed for CP, P, Ca, Mg, K, and Na. Total nitrogen was determined by the Kjeldahl method (Peech et al. 1947), then N levels were multiplied by 6.25 and expressed as percent CP. Levels of Ca, Mg, K, and Na were determined by atomic absorption spectrometry (Boettner and Grunder 1968). Lanthanum oxide was added to Ca and Mg samples to reduce interference. Phosphorus was determined by the rapid digestion method (Bolin and Stramberg 1944). All nutrient percentages are expressed as percentage oven-dry weight.

Rainfall on both sites was recorded monthly throughout the study.

Data were analyzed by analysis of variance. *F*-ratios were calculated for years, months, species, and month-by-species interaction. Duncan's multiple-range test was used to make all possible comparisons among means for species (Steel and Torrie 1960). All statistical comparisons were made at the 0.05 level of probability.

## RESULTS AND DISCUSSION

### CRUDE PROTEIN

Average CP content (over the 2-year study period) of the grasses from the sandy range site is given in table 6. The average monthly CP content of the same grasses is shown in table 7. Hooded windmillgrass and fringeleaf paspalum contained significantly higher levels of CP than the other species, and tanglehead had significantly lower. The differences between the 2 years (1975-76 and 1976-77) and among collection dates were both significant.

The mean CP levels of short grasses, mid and  
(Continued on page 11.)

Table 3. — Phenology of short grasses on the sandy range site on the 24 collection dates

Collection period	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Sept. 1975	Mature	Mature	Mature	Mature	Dough	Mature	Mature	Mature
Oct. 1975	Mature	Dormant	Mature	Mature	Dormant	Mature	Mature	Mature
Nov. 1975	Mature	Dormant	Dormant	Mature	Dormant	Dormant	Dormant	Dormant
Dec. 1975	Semidormant	(1)	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Jan. 1976	(1)	(1)	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Feb. 1976	Early vegetative	Early vegetative	Dormant	Dormant	Early vegetative	Early vegetative	Dormant	Dormant
Mar. 1976	Vegetative and immature	Vegetative	Dormant	Early vegetative	Vegetative	Vegetative	Early vegetative	Dormant
Apr. 1976	Vegetative and immature	Vegetative	Dormant	Vegetative and immature	Vegetative and immature	Vegetative and immature	Vegetative	Early vegetative
May 1976	Vegetative and immature	Immature and mature	Vegetative	Vegetative and immature	Immature	Immature	Immature	Vegetative
June 1976	Immature and mature	Mature	Vegetative	Immature and mature	Immature and mature	Immature	Immature	Immature
July 1976	Immature and mature	Vegetative and immature	Vegetative and immature	Immature and mature	Mature	Vegetative and immature	Mature	Vegetative and immature
Aug. 1976	Immature and mature	Immature	Immature	Immature and mature	Mature	Mature	Mature	Vegetative and immature
Sept. 1976	Mature	Immature and mature	Immature and mature	Mature	Mature	Mature	Mature	Mature
Oct. 1976	Mature	Mature	Mature	Mature	Dough	Mature	Mature	Mature
Nov. 1976	Mature	Dormant	Mature	Mature	Dormant	Mature	Dormant	Dormant
Dec. 1976	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Jan. 1977	Dormant	(1)	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Feb. 1977	Dormant	Early vegetative	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Mar. 1977	Early vegetative	Immature	Early vegetative	Early vegetative	Early vegetative	Dormant	Early vegetative	Early vegetative
Apr. 1977	Vegetative	Immature	Vegetative	Vegetative	Vegetative	Early vegetative	Vegetative	Vegetative
May 1977	Immature	Mature	Vegetative and immature	Immature	Immature	Vegetative	Immature	Immature
June 1977	Mature	Vegetative and immature	Immature	Immature	Immature and mature	Immature	Mature	Immature
July 1977	Mature	Mature	Immature and mature	Mature	Mature	Mature	Mature	Mature
Aug. 1977	Mature	Mature	Mature	Mature	Mature	Mature	Mature	Mature

1 Insufficient plant development for sampling.

Table 4. — Phenology of mid and tall grasses on the sandy range site on the 24 collection dates

Collection period	Balsamscale	Brownseed paspalum	Crinkle-awn	Seacoast bluestem	Switchgrass	Tanglehead	Texas grass
Sept. 1975	Mature	Mature	Immature	Immature	Mature	Mature	Dough
Oct. 1975	Mature	Dough	Mature	Mature	Dough	Overripe	Dormant
Nov. 1975	Dormant	Dormant	Mature	Mature	Dormant	Dormant	Dormant
Dec. 1975	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Jan. 1976	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant	Early vegetative
Feb. 1976	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant	Vegetative
Mar. 1976	Early vegetative	Early vegetative	Early vegetative	Dormant	Early vegetative	Dormant	Vegetative
Apr. 1976	Vegetative	Vegetative	Vegetative	Early vegetative	Vegetative	Early vegetative	Vegetative
May 1976	Vegetative and immature	Vegetative and immature	Vegetative	Vegetative	Vegetative and immature	Vegetative	Immature
June 1976	Immature	Immature	Vegetative	Vegetative	Immature	Vegetative and immature	Immature and mature
July 1976	Immature and mature	Mature	Vegetative and immature	Vegetative	Immature and mature	Immature	Mature
Aug. 1976	Mature	Mature	Immature	Vegetative	Mature	Immature	Mature
Sept. 1976	Mature	Mature	Mature	Immature	Mature	Mature	Mature
Oct. 1976	Mature	Dough	Overripe	Mature	Mature	Mature	Dough
Nov. 1976	Overripe	Dormant	Dormant	Mature	Dough	Overripe	Dormant
Dec. 1976	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Jan. 1977	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Feb. 1977	Dormant	Early vegetative	Dormant	Early vegetative	Early vegetative	Dormant	Early vegetative
Mar. 1977	Early vegetative	Early vegetative	Early vegetative	Early vegetative	Vegetative	Dormant	Vegetative
Apr. 1977	Vegetative	Vegetative	Vegetative	Vegetative	Vegetative	Early vegetative	Immature
May 1977	Immature	Vegetative	Vegetative	Vegetative	Vegetative and immature	Vegetative	Immature and mature
June 1977	Immature	Immature	Vegetative and immature	Vegetative	Immature	Vegetative	Mature
July 1977	Mature	Mature	Immature	Vegetative	Mature	Immature	Mature
Aug. 1977	Mature	Dough	Mature	Vegetative	Mature	Immature	Dough

Table 5. — Phenology of grasses on the red sandy loam site on the 24 collection dates

Collection period	Fringed signalgrass	Hooded windmillgrass	Red lovegrass	Roemer threawn	Sandbur	Slender grama
Sept. 1975	Mature	Mature	Immature and mature	Mature	Mature	Immature and mature
Oct. 1975	Mature	Mature	Mature	Mature	Mature	Mature
Nov. 1975	Dormant	Mature	Mature	Dormant	Dormant	Dormant
Dec. 1975	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Jan. 1976	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Feb. 1976	Dormant	Dormant	Dormant	Dormant	Early vegetative	Dormant
Mar. 1976	Dormant	Dormant	Vegetative	Dormant	Vegetative and immature	Dormant
Apr. 1976	Early vegetative	Vegetative and immature	Vegetative and immature	Early vegetative	Immature	Early vegetative
May 1976	Vegetative and immature	Immature	Immature	Vegetative and immature	Vegetative and immature	Vegetative
June 1976	Mature	Mature	Mature	Immature	Mature	Vegetative and immature
July 1976	Vegetative and immature	Vegetative and immature	Vegetative and immature	Mature	Vegetative and immature	Immature
Aug. 1976	Immature	Immature and mature	Immature	Mature	Immature	Mature
Sept. 1976	Immature and mature	Immature	Vegetative and immature	Mature	Immature and mature	Mature
Oct. 1976	Mature	Mature	Mature	Mature	Mature	Mature
Nov. 1976	Mature	Mature	Mature	Dormant	Mature	Dormant
Dec. 1976	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Jan. 1977	Dormant	Dormant	Dormant	Dormant	Dormant	Dormant
Feb. 1977	Early vegetative	Dormant	Early vegetative	Early vegetative	Dormant	Dormant
Mar. 1977	Vegetative	Dormant	Vegetative	Vegetative and immature	Vegetative and immature	Early vegetative and immature
Apr. 1977	Immature	Vegetative	Immature and mature	Immature	Immature	Immature
May 1977	Immature and mature	Immature	Immature and mature	Immature	Immature	Immature
June 1977	Vegetative and immature	Vegetative and immature	Vegetative and immature	Immature and mature	Vegetative and immature	Mature
July 1977	Mature	Mature	Mature	Mature	Mature	Mature
Aug. 1977	Mature	Mature	Mature	Mature	Mature	Mature

**Table 6. — Average crude protein (CP) and mineral content of grasses on the sandy range site over the 2-year study period, percent by weight**

Grass species	CP	P	Ca	Mg	Na	K
Short grasses:						
Fringed signalgrass	7.6abc <sup>1</sup>	0.07bc	0.45bc	0.13bc	0.04de	1.38bc
Fringeleaf paspalum	9.0a	.08b	.70a	.20a	.12b	1.68a
Hairy grama	5.4def	.04d	.36de	.06f	.05de	.59hi
Hooded windmillgrass	8.8a	.10a	.49b	.10de	.15a	1.47ab
Knotgrass	6.4def	.06bcd	.41bcd	.14b	.09c	1.09de
Red lovegrass	5.4def	.06bcd	.30e	.07f	.07cd	.75ghi
Roemer three-awn	5.2def	.05cd	.29e	.06f	.04de	.54hi
Sandbur	6.7bcd	.07bc	.37cde	.11cd	.12b	1.37bc
Mid and tall grasses:						
Balsamgrass	5.5def	.06bcd	.30e	.08ef	.04de	1.00defg
Brownseed paspalum	5.2def	.05cd	.45bc	.14b	.04de	1.07def
Crinkle-awn	5.1def	.05cd	.45bc	.14b	.04de	.78ghi
Seacoast bluestem	5.0ef	.05cd	.30e	.07f	.04de	.83fgh
Switchgrass	4.9ef	.05cd	.31e	.10de	.07cd	1.05def
Tanglehead	4.6f	.06bcd	.29e	.08ef	.03e	.85efg
Texas grass	8.0ab	.08b	.49b	.10de	.07cd	1.19cd

<sup>1</sup>Means followed by the same letter are not significantly different (using Duncan's multiple-range test at the 0.05 probability level).

**Table 7. — Average crude protein content of grasses on the sandy range site on the 24 collection dates, percent by weight**

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Sept. 1975	5.5	5.2	3.2	4.8	4.1	5.7	5.0	4.4
Oct. 1975	4.5	4.6	3.6	4.8	4.2	4.8	3.3	5.3
Nov. 1975	6.1	5.8	4.1	5.9	4.2	3.0	3.3	4.7
Dec. 1975	5.7	( <sup>1</sup> )	3.7	5.9	2.6	3.4	2.8	4.6
Jan. 1976	6.7	( <sup>1</sup> )	4.1	9.8	4.3	3.3	3.6	4.5
Feb. 1976	8.9	12.2	4.4	7.8	5.5	6.0	3.1	4.9
Mar. 1976	7.6	10.2	4.0	9.4	5.3	5.1	6.4	5.5
Apr. 1976	12.6	12.8	4.6	12.4	9.1	9.2	6.7	10.7
May 1976	10.1	9.9	8.6	11.2	8.7	8.7	7.4	9.4
June 1976	5.9	6.2	4.7	9.9	5.5	5.3	5.0	5.3
July 1976	7.8	9.2	6.2	8.0	7.4	6.9	6.3	6.7
Aug. 1976	8.9	9.1	6.7	10.3	5.9	5.7	5.7	9.0
Sept. 1976	8.7	10.9	6.4	8.4	8.8	4.3	5.5	8.9
Oct. 1976	9.6	8.6	6.1	10.6	6.6	6.2	6.4	7.6
Nov. 1976	7.6	8.4	5.8	7.8	7.1	4.6	5.0	6.1
Dec. 1976	6.6	6.4	5.1	9.6	6.4	5.2	4.6	5.9
Jan. 1977	5.6	( <sup>1</sup> )	5.1	6.9	6.0	4.9	4.3	5.6
Feb. 1977	5.7	14.5	5.4	7.7	6.1	4.4	3.1	6.1
Mar. 1977	10.7	10.9	6.3	12.3	11.7	4.9	7.4	8.3
Apr. 1977	9.5	13.5	6.8	8.5	7.0	5.8	7.6	6.4
May 1977	8.6	9.0	6.3	9.7	8.9	6.8	5.0	8.4
June 1977	9.5	11.7	7.0	11.2	9.6	8.0	4.8	10.4
July 1977	4.0	8.0	5.0	9.5	3.9	3.5	8.0	6.9
Aug. 1977	4.6	4.7	4.7	8.1	4.3	3.9	3.2	4.5

See footnotes at end of table.

**Table 7. — Average crude protein content of grasses on the sandy range site on the 24 collection dates, percent by weight — Continued**

Collection period	Mid and tall grasses							Mean <sup>2</sup>
	Balsamscale	Brownseed paspalum	Crinkle-awn	Seacoast bluestem	Switchgrass	Tanglehead	Texas grass	
Sept. 1975	4.0	3.0	4.2	4.0	4.0	4.6	4.4	4.4
Oct. 1975	4.4	2.8	3.2	3.0	3.5	3.2	2.5	3.8
Nov. 1975	3.4	3.2	3.5	2.3	2.0	3.2	2.4	3.8
Dec. 1975	3.5	3.0	2.5	1.9	2.7	2.6	3.4	3.5
Jan. 1976	4.0	3.4	2.8	2.6	3.0	3.0	3.7	4.2
Feb. 1976	4.0	2.6	3.5	2.4	3.6	2.5	5.1	5.1
Mar. 1976	6.0	5.2	6.0	4.4	5.1	4.2	5.3	6.0
Apr. 1976	10.2	7.6	8.2	8.0	9.5	8.3	10.3	9.3
May 1976	7.3	9.2	9.0	8.3	9.0	7.5	13.6	9.2
June 1976	4.9	4.9	5.9	5.0	5.0	4.4	5.0	5.5
July 1976	5.5	7.3	6.6	6.9	4.6	6.4	9.7	7.0
Aug. 1976	4.9	6.1	4.7	5.7	4.5	5.2	8.8	6.7
Sept. 1976	5.5	5.4	5.2	5.9	5.5	4.6	10.5	7.0
Oct. 1976	6.2	4.7	5.9	4.7	3.5	4.5	9.5	6.7
Nov. 1976	4.5	3.2	4.2	4.6	3.3	4.2	5.9	5.5
Dec. 1976	4.4	3.5	4.2	3.8	2.4	3.4	6.7	5.2
Jan. 1977	3.9	3.8	4.2	3.9	2.7	3.1	6.3	4.7
Feb. 1977	5.5	4.0	4.3	5.5	5.1	2.7	8.5	5.9
Mar. 1977	7.8	10.9	6.4	5.5	6.0	3.8	12.3	8.3
Apr. 1977	9.3	8.6	9.1	8.4	11.2	8.0	10.6	8.7
May 1977	6.6	8.3	5.8	6.8	6.0	6.9	14.5	7.8
June 1977	6.4	7.0	5.3	7.0	5.6	7.2	11.2	8.1
July 1977	3.8	3.5	3.1	4.1	4.4	3.5	8.8	5.3
Aug. 1977	3.9	4.0	3.2	4.6	4.7	3.5	12.0	4.9
1975-76 mean <sup>2</sup> .....								5.8
1976-77 mean <sup>2</sup> .....								6.6

<sup>1</sup> Insufficient plant development for sampling.

<sup>2</sup> Mean for all 15 grasses.

**Table 8. — Average crude protein (CP) and mineral content of grasses on the red sandy loam range site over the 2-year study period, percent by weight**

Grass species	CP	P	Ca	Mg	Na	K
Fringed signalgrass.....	7.4a <sup>1</sup>	0.10a	0.50a	0.15b	0.03b	1.29a
Hooded windmillgrass.....	7.3a	.10a	.53a	.09b	.07a	1.10ab
Red lovegrass.....	6.9a	.09a	.34b	.08b	.05ba	.89bc
Roemer threeawn.....	6.4a	.09a	.35b	.07b	.04a	.62c
Sandbur.....	6.6a	.10a	.47a	.14a	.07a	1.37a
Slender grama.....	6.2a	.08a	.46a	.08b	.03b	.65c

<sup>1</sup>Means followed by the same letter are not significantly different (using Duncan's multiple-range test at the 0.05 probability level).

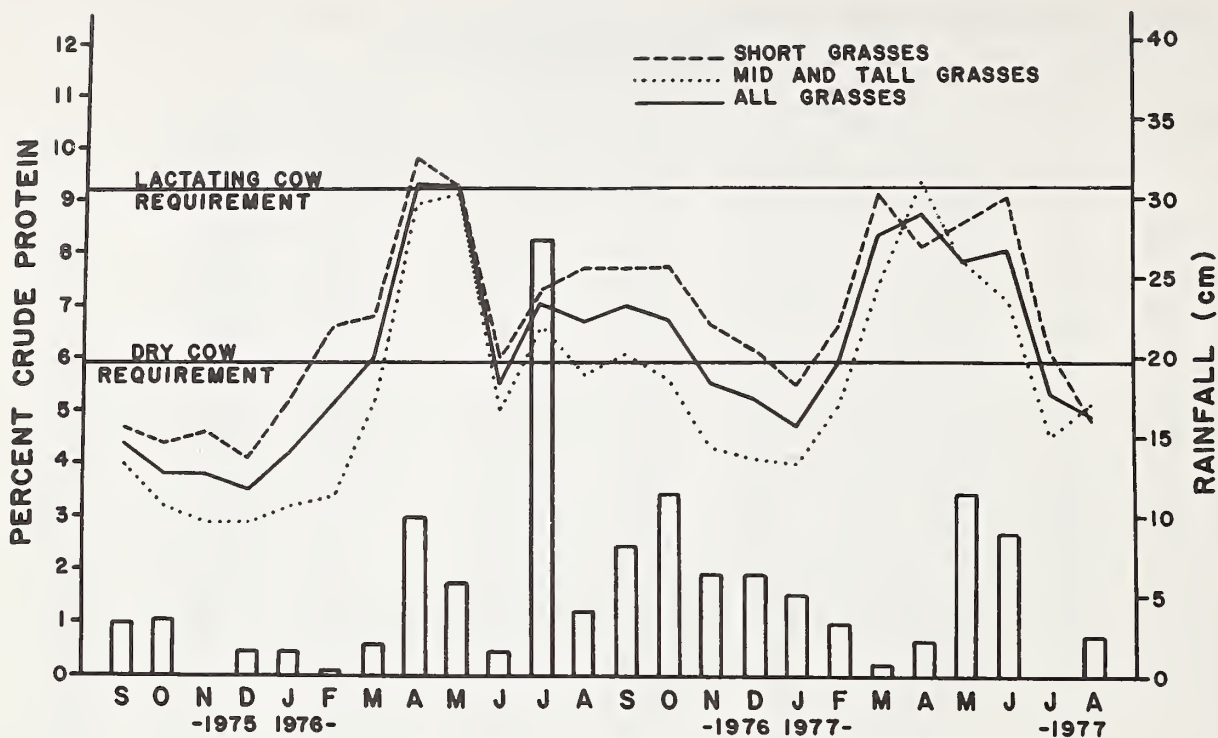


FIGURE 4. — Average crude protein content of grasses on the sandy range site.

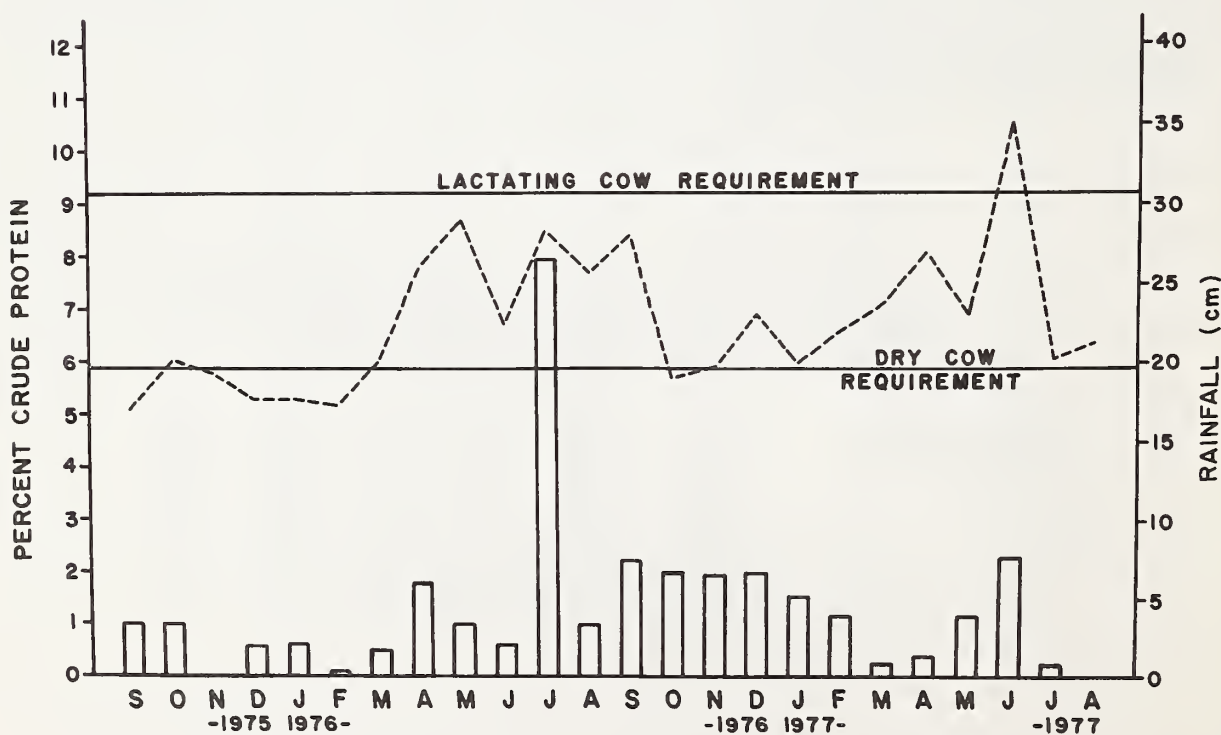


FIGURE 5. — Average crude protein content of grasses on the red sandy loam range site.

Table 9. — Average crude protein content of grasses on the red sandy loam range site on the 24 collection dates, percent by weight

Collection period	Fringed signalgrass	Hooded windmillgrass	Red lovegrass	Roemer threeawn	Sandbur	Slender grama	Mean
Sept. 1975	5.2	5.3	5.2	4.8	5.0	5.0	5.1
Oct. 1975	5.5	7.5	5.4	6.6	6.0	4.7	6.0
Nov. 1975	4.3	8.9	7.3	5.3	4.4	4.3	5.8
Dec. 1975	4.9	6.0	5.8	6.1	4.5	4.5	5.3
Jan. 1976	4.9	5.8	4.9	5.5	5.7	5.1	5.3
Feb. 1976	5.1	5.0	4.9	4.9	6.9	4.4	5.2
Mar. 1976	5.5	5.7	7.4	5.6	7.2	5.4	6.1
Apr. 1976	11.9	7.8	7.6	6.4	6.5	6.6	7.8
May 1976	9.8	8.7	10.0	8.6	8.0	6.8	8.7
June 1976	7.4	7.4	6.2	6.0	6.6	6.6	6.7
July 1976	8.3	10.9	8.9	7.8	8.3	6.5	8.5
Aug. 1976	10.4	6.4	8.2	6.7	8.5	6.0	7.7
Sept. 1976	9.4	8.9	9.7	7.2	7.6	7.6	8.4
Oct. 1976	5.7	6.2	5.5	6.2	5.9	4.7	5.7
Nov. 1976	5.8	5.9	5.6	7.1	6.5	4.5	5.9
Dec. 1976	8.3	7.7	6.0	7.6	5.4	6.4	6.9
Jan. 1977	6.8	5.9	5.1	5.9	6.6	5.7	6.0
Feb. 1977	7.6	5.3	8.2	8.7	4.2	5.5	6.6
Mar. 1977	7.5	4.7	7.7	8.0	6.4	8.1	7.1
Apr. 1977	6.5	8.7	8.6	7.5	8.5	9.0	8.1
May 1977	8.7	5.8	7.1	5.9	6.6	7.1	6.9
June 1977	11.5	13.7	9.7	7.0	9.5	11.5	10.5
July 1977	7.5	7.5	4.9	4.4	6.6	5.5	6.1
Aug. 1977	7.4	8.1	5.8	4.2	6.6	6.0	6.4
1975-76 mean							6.5
1976-77 mean							7.0

tall grasses, and all grasses from the sandy site are shown in figure 4. Throughout the 2 years, short grasses were generally higher in CP than mid and tall grasses, probably because the mid and tall grasses' culms are more fibrous and coarser than those of short grasses and have lower levels of CP (Polk et al. 1976). Crude protein was highest during spring, when rainfall was high and plants were just beginning to grow. Lowest CP levels occurred in late fall and winter or during periods of high temperature and low rainfall in summer.<sup>2</sup> Crude protein levels were higher during the fall and winter of 1976-77 than during the same period for 1975-76, probably a result of greater rainfall during fall and winter 1976-77.

The 2-year mean CP content for the grasses from the red sandy loam site is shown in table 8. Crude protein contents ranged from 6.2% for slender grama to 7.4% for fringed signalgrass, but did

not differ significantly between any of the six grasses. Variance between the 2 years of the study was not significant, but significant differences were found among collection dates (table 9).

The average CP content of the grasses from the red sandy loam site is shown in figure 5. Crude protein content was roughly the same as that for all the sandy-site grasses; the only apparent difference being that during both years, CP was higher in late fall and winter on the red sandy loam site.

Beef cattle protein requirements<sup>3</sup> are indicated in figures 4 and 5. The mean CP level for all species from the sandy site (fig. 4) usually met the dry-cow needs except in late fall and winter and during dry periods in summer and fall, but mean CP levels never met the needs of lactating cows. The mean CP level for the short grasses usually fulfilled the dry-cow requirement except during fall and winter 1975-76, and met or nearly met the protein requirement for lactating cows during

<sup>2</sup>These findings are in general agreement with those reported by Willard and Schuster (1973) and Varner and Blankenship (1978).

<sup>3</sup>All cattle nutrient requirements are from the National Research Council (1976).

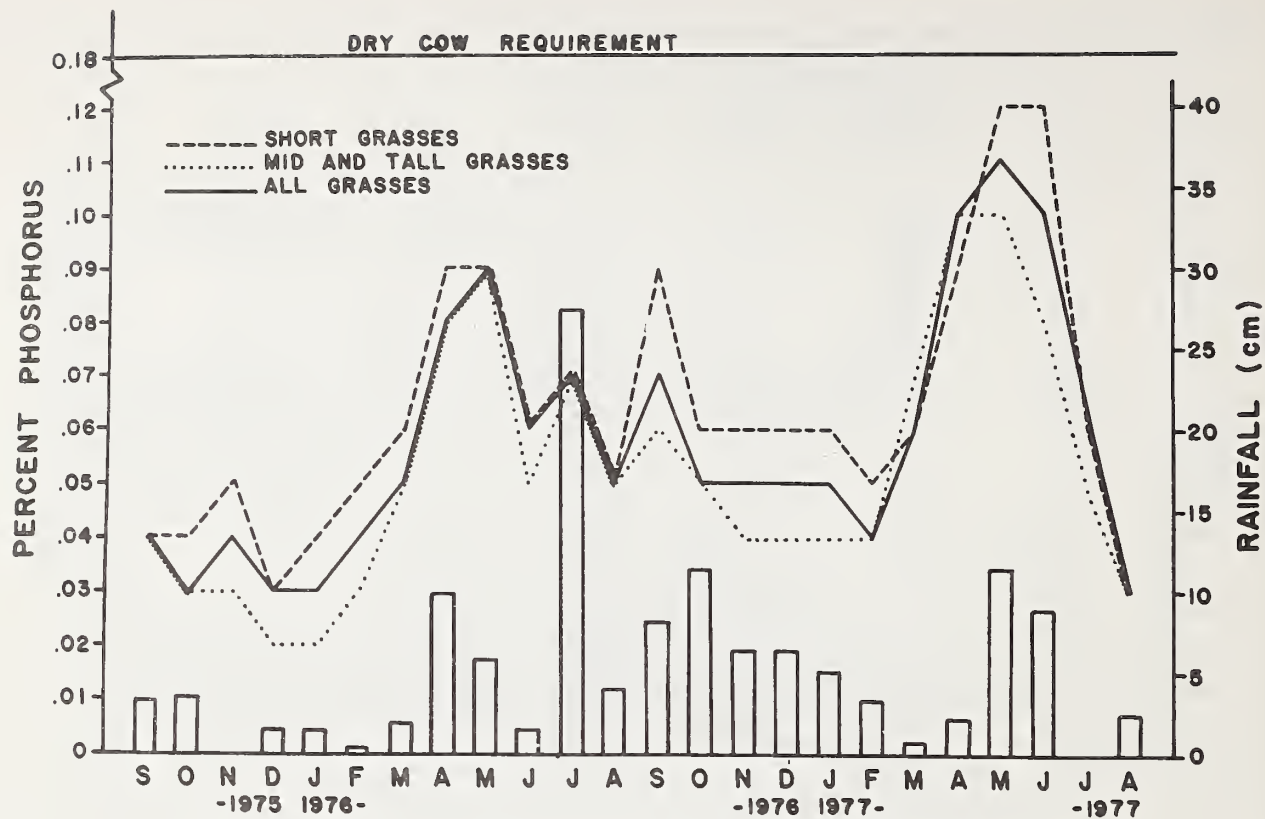


FIGURE 6. — Average phosphorus content of grasses on the sandy range site.

Table 10. — Average phosphorus content of grasses on the sandy range site on the 24 collection dates, percent by weight

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Sept. 1975	0.05	0.04	0.03	0.05	0.03	0.04	0.04	0.03
Oct. 1975	.04	.04	.03	.03	.03	.04	.04	.05
Nov. 1975	.04	.05	.03	.08	.03	.03	.02	.08
Dec. 1975	.03	( <sup>1</sup> )	.03	.03	.02	.02	.03	.05
Jan. 1976	( <sup>1</sup> )	( <sup>1</sup> )	.03	.08	.02	.03	.02	.03
Feb. 1976	.06	.08	.03	.10	.04	.04	.03	.03
Mar. 1976	.05	.07	.03	.13	.04	.04	.06	.05
Apr. 1976	.13	.09	.03	.14	.08	.08	.05	.09
May 1976	.09	.06	.08	.17	.07	.10	.07	.06
June 1976	.05	.05	.04	.15	.04	.06	.04	.04
July 1976	.07	.07	.06	.10	.06	.06	.05	.06
Aug. 1976	.05	.07	.05	.07	.05	.05	.03	.06
Sept. 1976	.13	.11	.05	.11	.08	.03	.05	.13
Oct. 1976	.05	.05	.05	.09	.04	.07	.05	.06
Nov. 1976	.07	.07	.05	.06	.04	.05	.05	.08
Dec. 1976	.06	.05	.04	.07	.05	.08	.04	.05
Jan. 1977	.06	( <sup>1</sup> )	.05	.07	.06	.05	.06	( <sup>2</sup> )

See footnotes at end of table.

Table 10. — Average phosphorus content of grasses on the sandy range site on the 24 collection dates, percent by weight — Continued

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Feb. 1977	0.04	0.11	0.02	0.05	0.06	0.05	0.02	0.04
Mar. 1977	.06	.08	.04	.07	.09	.05	.07	.05
Apr. 1977	.06	.07	.04	.20	.06	.18	.05	.09
May 1977	.11	.18	.06	.23	.11	.08	.07	.11
June 1977	.13	.18	.07	.09	.13	.13	.05	.18
July 1977	.06	.07	.02	.18	.03	.05	.05	.05
Aug. 1977	.02	.03	.02	.06	.02	.03	.02	.03
Mid and tall grasses								
	Balsamscale	Brownseed paspalum	Crinkle-awn	Seacoast bluestem	Switchgrass	Tanglehead	Texas grass	Mean <sup>3</sup>
Sept. 1975	0.04	0.03	0.03	0.04	0.03	0.04	0.05	0.04
Oct. 1975	.03	.02	.02	.02	.03	.03	.03	.03
Nov. 1975	.04	.02	.02	.02	.02	.03	.03	.04
Dec. 1975	.03	.02	.03	.02	.02	.03	.02	.03
Jan. 1976	.02	.02	.02	.03	.01	.02	.04	.03
Feb. 1976	.04	.03	.04	.03	.03	.03	.04	.04
Mar. 1976	.06	.05	.05	.04	.04	.05	.04	.05
Apr. 1976	.10	.07	.06	.07	.09	.09	.07	.08
May 1976	.10	.09	.08	.09	.07	.09	.11	.09
June 1976	.06	.06	.05	.05	.06	.05	.04	.06
July 1976	.06	.08	.06	.07	.06	.07	.08	.07
Aug. 1976	.05	.06	.05	.05	.04	.05	.06	.05
Sept. 1976	.05	.05	.07	.06	.06	.04	.10	.07
Oct. 1976	.06	.05	.05	.04	.03	.04	.08	.05
Nov. 1976	.05	.04	.04	.04	.03	.04	.04	.05
Dec. 1976	.04	.03	.03	.04	.03	.03	.05	.05
Jan. 1977	.04	.03	.03	.04	.04	.05	.06	.05
Feb. 1977	.03	.03	.04	.04	.04	.01	.08	.04
Mar. 1977	.07	.08	.07	.05	.05	.05	.09	.06
Apr. 1977	.11	.10	.08	.07	.15	.12	.09	.10
May 1977	.09	.09	.07	.09	.05	.09	.25	.11
June 1977	.06	.08	.05	.10	.06	.06	.13	.10
July 1977	.04	.04	.03	.05	.05	.05	.09	.06
Aug. 1977	.04	.03	.02	.03	.03	.02	.05	.03
1975-76 mean								.05
1976-77 mean								.06

<sup>1</sup>Insufficient plant development for sampling.

<sup>2</sup>Insufficient sample for analyses.

<sup>3</sup>Mean for all 15 grasses.

periods of high rainfall in spring and summer. Grasses from the red sandy loam site (fig. 5) generally met dry-cow protein requirements except during the winter of 1975-76, and approached or met lactating-cow protein requirements in the spring or during periods of high rainfall in summer.

Cattle grazing the grasses we analyzed would likely gain a higher percentage of protein than the

values we reported; the quality of hand-plucked forage seldom approaches that which the animals select, since animals seem to have the inherent ability to select quality forage (Van Dyne and Torrell 1964). Also, shrubs and forbs may contribute large amounts of protein during stress periods (Cook and Harris 1950). Nevertheless, our data provide a good estimate of yearly CP content.

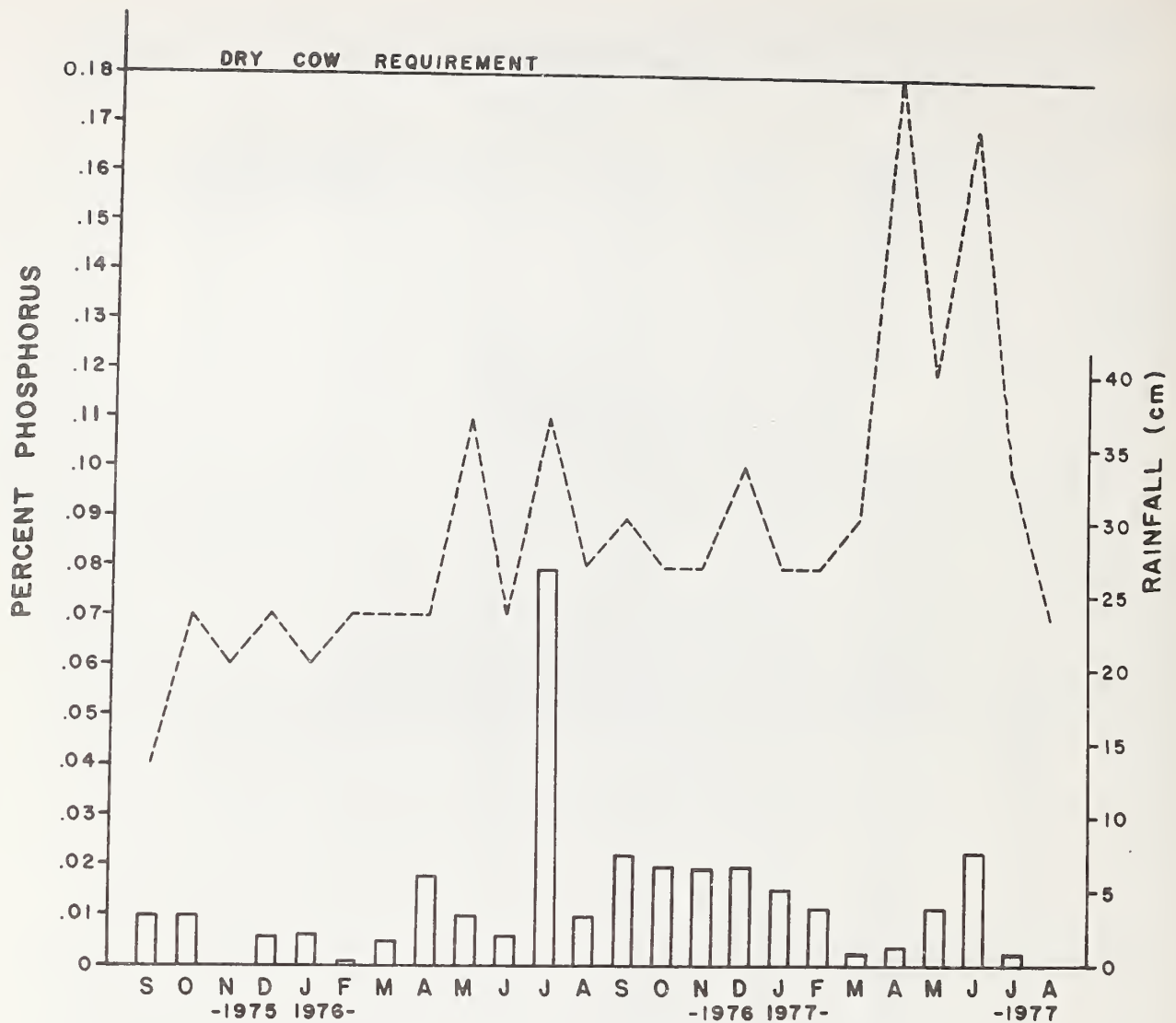


FIGURE 7. — Average phosphorus content of grasses on the red sandy loam range site.

Livestock grazing sandy and red sandy loam range sites will probably need supplemental protein from December through February or early March when spring growth of forage is resumed. A more pronounced protein deficiency exists during a dry fall and winter.

#### PHOSPHORUS

Over the 2-year study period on the sandy site, hooded windmillgrass contained significantly higher levels of P than the other species, and hairy grama contained significantly lower levels (table

6). Variance between the 2 years and among collection dates was significant. The P content of the sandy-site species on each collection date is shown in table 10. Average P levels were generally higher for short grasses than for mid and tall grasses throughout the study (fig. 6). Phosphorus levels followed the same trend as CP, being highest in spring when rainfall was high and the plants were just beginning growth, and lowest in late fall and winter or during periods of high temperature and low rainfall in summer and fall. Phosphorus levels were higher during the wet fall and winter of 1976-77 than during the drier fall and winter of 1975-76.

Table 11. — Average phosphorus content of grasses on the red sandy loam range site on the 24 collection dates, percent by weight

Collection period	Fringed signalgrass	Hooded windmillgrass	Red lovegrass	Roemer threeawn	Sandbur	Slender grama	Mean
Sept. 1975	0.05	0.05	0.05	0.03	0.05	0.03	0.04
Oct. 1975	.04	.12	.05	.07	.10	.03	.07
Nov. 1975	.05	.08	.07	.07	.07	.04	.06
Dec. 1975	.07	.08	.07	.08	.07	.04	.07
Jan. 1976	.05	.06	.04	.07	.07	.05	.06
Feb. 1976	.08	.08	.06	.06	.07	.05	.07
Mar. 1976	.07	.08	.07	.05	.11	.06	.07
Apr. 1976	.09	.07	.07	.05	.08	.06	.07
May 1976	.13	.11	.12	.11	.13	.08	.11
June 1976	.08	.10	.06	.07	.05	.04	.07
July 1976	.09	.14	.10	.11	.13	.08	.11
Aug. 1976	.09	.07	.10	.07	.07	.06	.08
Sept. 1976	.10	.08	.11	.08	.11	.07	.09
Oct. 1976	.08	.07	.07	.06	.11	.06	.08
Nov. 1976	.06	.06	.09	.07	.11	.08	.08
Dec. 1976	.16	.12	.06	.07	.06	.10	.10
Jan. 1977	.08	.10	.06	.08	.07	.09	.08
Feb. 1977	.09	.06	.09	.10	.08	.08	.08
Mar. 1977	.10	.07	.09	.10	.07	.08	.09
Apr. 1977	.15	.20	.22	.17	.22	.13	.18
May 1977	.16	.07	.11	.10	.14	.14	.12
June 1977	.19	.19	.17	.12	.15	.19	.17
July 1977	.11	.12	.07	.14	.08	.06	.10
Aug. 1977	.07	.08	.04	.05	.09	.07	.07
1975-76 mean							.07
1976-77 mean							.10

Among the grasses from the red sandy loam site, no significant differences were found in P content (table 8). Significant differences were found between the 2 years and among collection dates (table 11). Phosphorus levels showed the same seasonal trend (fig. 7) as those shown by sandy-site grasses (fig. 6) except that P levels were higher on the red sandy loam site.

The P requirement of beef cattle is 0.18% for dry cows. The P requirement of lactating cows is dependent on a variety of factors and ranges from 0.18 to 0.39% of the dry ration (National Research Council 1976). Dry-cow P requirements were never met on the sandy site (fig. 6) and were met only in April 1977 on the red sandy loam site (fig. 7). The P requirements for a lactating cow were never met on the sandy site and were probably never met on the red sandy loam site.<sup>4</sup>

Livestock on sandy and red sandy loam range

sites will probably need P supplementation throughout the year. Despite grazing animals' inherent ability to select quality forage (Cook et al. 1948, Van Dyne and Torrell 1964), it is doubtful that they could get enough P with levels in the grasses so low. The need is especially critical during late fall and winter, and on the sandy site.

#### CALCIUM

Over the 2-year study period, the average Ca content of the sandy-site grasses ranged from a low of 0.29% for crinkle-awn, Roemer threeawn, and tanglehead to a high of 0.70% for fringleaf paspalum (table 6). Fringleaf paspalum contained significantly higher levels of Ca than the other species. Significant differences were found among collection dates (table 12), and a significant month-species interaction was observed. The wide variation in the Ca content of several species on different collection dates would contribute to their interaction. Calcium levels were higher for short grasses than for mid and tall grasses throughout

<sup>4</sup>These findings agreed with those of Black et al. (1943), who reported low P levels in grasses from the King Ranch in south Texas.

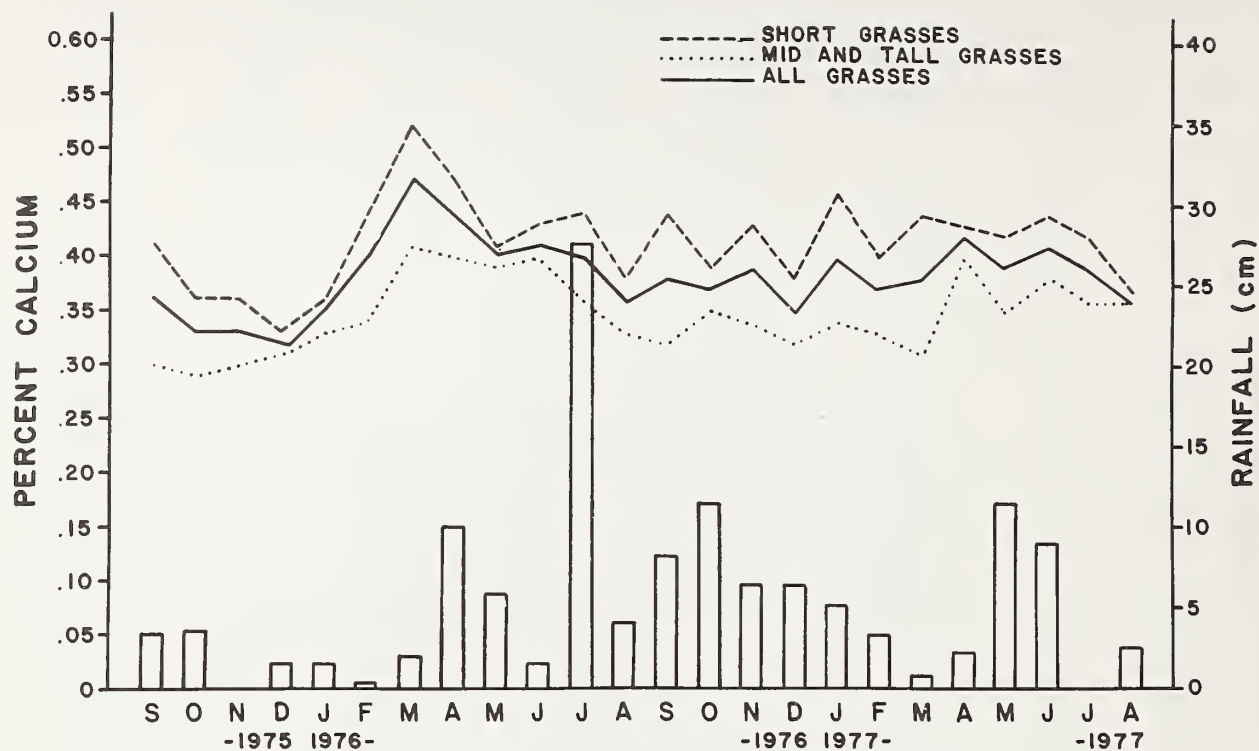


FIGURE 8. — Average calcium content of grasses on the sandy range site.

Table 12. — Average calcium content of grasses on the sandy range site on the 24 collection dates, percent by weight

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Sept. 1975	0.35	0.64	0.27	0.49	0.47	0.38	0.36	0.28
Oct. 1975	.26	.57	.31	.34	.45	.36	.29	.27
Nov. 1975	.29	.55	.28	.45	.49	.23	.30	.29
Dec. 1975	.21	( <sup>1</sup> )	.29	.49	.38	.30	.23	.38
Jan. 1976	( <sup>1</sup> )	( <sup>1</sup> )	.35	.56	.34	.24	.25	.42
Feb. 1976	.58	.60	.44	.46	.58	.22	.25	.42
Mar. 1976	.56	.79	.30	.54	.50	.26	.48	.69
Apr. 1976	.46	.84	.32	.53	.45	.40	.34	.42
May 1976	.30	.63	.53	.49	.42	.29	.29	.30
June 1976	.30	.72	.45	.53	.42	.32	.37	.29
July 1976	.30	.82	.44	.55	.39	.30	.38	.33
Aug. 1976	.32	.72	.42	.41	.35	.23	.28	.29
Sept. 1976	.59	.54	.52	.47	.38	.40	.26	.32
Oct. 1976	.47	.63	.32	.39	.24	.39	.31	.40
Nov. 1976	.62	.72	.29	.45	.48	.22	.24	.43
Dec. 1976	.45	.75	.31	.41	.38	.26	.21	.30
Jan. 1977	.78	( <sup>1</sup> )	.27	.54	.61	.28	.27	( <sup>2</sup> )
Feb. 1977	.52	.71	.28	.50	.31	.26	.17	.44
Mar. 1977	.47	.76	.38	.49	.36	.27	.29	.50
Apr. 1977	.45	.65	.40	.56	.27	.46	.28	.37

See footnotes at end of table.

Table 12 — Average calcium content of grasses on the sandy range site on the 24 collection dates, percent by weight — Continued

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
May 1977	0.42	0.79	0.37	0.49	0.43	0.25	0.34	0.30
June 1977	.50	.80	.38	.56	.42	.28	.26	.32
July 1977	.51	.63	.41	.55	.30	.35	.26	.32
Aug. 1977	.36	.65	.30	.54	.25	.25	.25	.37
	Mid and tall grasses							
	Balsamscale	Brownseed paspalum	Crinkle-awn	Seacoast bluestem	Switchgrass	Tanglehead	Texas grass	Mean <sup>3</sup>
Sept. 1975	0.35	0.35	0.28	0.23	0.23	0.26	0.39	0.36
Oct. 1975	.26	.28	.26	.21	.28	.30	.44	.33
Nov. 1975	.33	.39	.27	.21	.22	.28	.41	.33
Dec. 1975	.30	.42	.29	.22	.31	.33	.29	.32
Jan. 1976	.25	.45	.33	.32	.28	.31	.40	.35
Feb. 1976	.26	.40	.34	.26	.29	.33	.51	.40
Mar. 1976	.36	.51	.51	.38	.35	.23	.52	.47
Apr. 1976	.31	.45	.35	.40	.36	.39	.52	.44
May 1976	.32	.49	.31	.45	.36	.31	.48	.40
June 1976	.38	.57	.32	.49	.29	.26	.48	.41
July 1976	.25	.59	.25	.37	.27	.34	.43	.40
Aug. 1976	.37	.44	.27	.35	.31	.20	.37	.36
Sept. 1976	.24	.36	.25	.37	.40	.22	.41	.38
Oct. 1976	.29	.41	.28	.29	.52	.19	.49	.37
Nov. 1976	.34	.40	.28	.30	.28	.33	.46	.39
Dec. 1976	.26	.45	.25	.32	.28	.18	.50	.35
Jan. 1977	.25	.44	.26	.27	.28	.26	.63	.40
Feb. 1977	.27	.41	.25	.28	.32	.32	.47	.37
Mar. 1977	.32	.41	.28	.23	.28	.19	.45	.38
Apr. 1977	.32	.47	.41	.27	.32	.41	.61	.42
May 1977	.32	.42	.31	.20	.29	.31	.63	.39
June 1977	.30	.50	.25	.30	.28	.48	.52	.41
July 1977	.27	.56	.27	.18	.39	.27	.61	.39
Aug. 1977	.28	.53	.25	.32	.25	.19	.68	.36
1975-76 mean.....								.38
1976-77 mean.....								.39

<sup>1</sup> Insufficient plant development for sampling.

<sup>2</sup> Insufficient sample for analyses.

<sup>3</sup> Mean for all 15 grasses.

the 2 years (fig. 8), and Ca levels remained relatively constant throughout the 2-year study period.<sup>5</sup>

On the red sandy loam site, fringed signalgrass, hooded windmillgrass, sandbur, and slender grama were significantly higher in Ca than Roemer three-awn and red lovegrass over the 2-year study period (table 8). The variance between the two years was

significant, but no significant differences were found among collection dates (table 13). There was no relation between Ca content of red-sandy-loam-site grasses and either season or rainfall, except for a slight decline in late summer (fig. 9).

The Ca requirement of beef cattle depends on a variety of factors and ranges from 0.18% to 0.44% of the dry ration (National Research Council 1976). The Ca requirements of dry and lactating cows does not differ. All grasses from both sites probably

<sup>5</sup>These data are similar to those reported by Nelson et al. (1970).

Table 13. — Average calcium content of grasses on the red sandy loam range site on the 24 collection dates, percent by weight

Collection period	Fringed signalgrass	Hooded windmillgrass	Red lovegrass	Roemer threeawn	Sandbur	Slender grama	Mean
Sept. 1975	0.28	0.32	0.25	0.25	0.29	0.46	0.31
Oct. 1975	.32	.46	.27	.31	.31	.38	.34
Nov. 1975	.43	.48	.42	.42	.35	.49	.43
Dec. 1975	.51	.57	.44	.38	.50	.48	.48
Jan. 1976	.46	.50	.30	.41	.49	.45	.44
Feb. 1976	.59	.46	.37	.27	.50	.46	.44
Mar. 1976	.53	.65	.36	.51	.61	.49	.53
Apr. 1976	.31	.70	.32	.35	.65	.43	.46
May 1976	.30	.54	.34	.36	.34	.52	.40
June 1976	.46	.47	.37	.40	.37	.45	.42
July 1976	.33	.49	.34	.52	.33	.32	.39
Aug. 1976	.38	.39	.33	.27	.27	.43	.35
Sept. 1976	.44	.58	.32	.38	.50	.66	.48
Oct. 1976	.79	.50	.26	.46	.64	.47	.52
Nov. 1976	.77	.82	.31	.37	.45	.51	.54
Dec. 1976	.71	.56	.30	.31	.42	.55	.48
Jan. 1977	.67	.75	.33	.48	.52	.45	.53
Feb. 1977	.61	.42	.41	.26	.67	.54	.49
Mar. 1977	.39	.50	.26	.26	.54	.55	.42
Apr. 1977	.38	.42	.58	.29	.54	.49	.45
May 1977	.75	.59	.26	.33	.65	.33	.49
June 1977	.58	.48	.32	.27	.35	.35	.39
July 1977	.49	.49	.29	.28	.46	.36	.40
Aug. 1977	.48	.45	.30	.22	.45	.30	.37
1975-76 mean							.42
1976-77 mean							.46

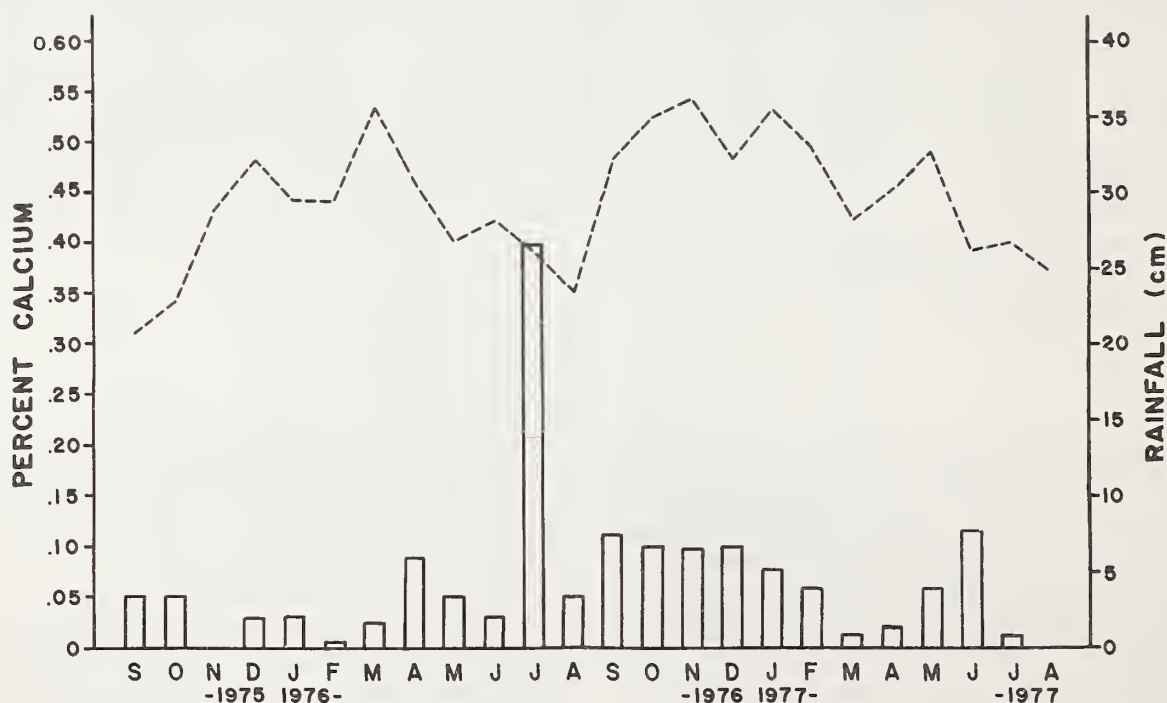


FIGURE 9. — Average calcium content of grasses on the red sandy loam range site.

contained adequate levels of Ca throughout the study.

## MAGNESIUM

Over the entire study period on the sandy range site, mean Mg contents ranged from 0.06% to

0.20% (table 6). Fringeleaf paspalum was significantly higher in Mg than other species. The variance between the 2 years and among collection dates was significant (table 14). A significant month-species interaction was observed, which was contributed to by wide variation in the Mg content of several species on different collection dates. Short grasses were generally higher in Mg content than mid and

Table 14. — Average magnesium content of grasses on the sandy range site on the 24 collection dates, percent by weight

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Sept. 1975	0.09	0.16	0.04	0.06	0.13	0.05	0.05	0.09
Oct. 1975	.09	.11	.05	.06	.11	.06	.05	.10
Nov. 1975	.10	.11	.04	.06	.13	.07	.04	.08
Dec. 1975	.07	( <sup>1</sup> )	.03	.06	.08	.05	.03	.09
Jan. 1976	( <sup>1</sup> )	( <sup>1</sup> )	.03	.12	.06	.06	.03	.08
Feb. 1976	.11	.16	.04	.07	.10	.05	.04	.08
Mar. 1976	.09	.15	.03	.10	.08	.04	.05	.08
Apr. 1976	.17	.20	.03	.10	.13	.06	.06	.08
May 1976	.08	.22	.10	.09	.14	.09	.06	.09
June 1976	.16	.23	.09	.15	.19	.08	.09	.10
July 1976	.16	.29	.08	.15	.16	.08	.09	.11
Aug. 1976	.13	.24	.08	.11	.17	.08	.06	.12
Sept. 1976	.18	.24	.07	.10	.20	.07	.08	.14
Oct. 1976	.16	.19	.07	.11	.18	.07	.06	.10
Nov. 1976	.12	.17	.04	.06	.14	.06	.05	.13
Dec. 1976	.11	.13	.04	.10	.09	.05	.05	.11
Jan. 1977	.07	( <sup>1</sup> )	.04	.06	.06	.05	.03	( <sup>2</sup> )
Feb. 1977	.12	.25	.05	.09	.06	.05	.03	.09
Mar. 1977	.17	.22	.05	.16	.20	.05	.08	.13
Apr. 1977	.16	.23	.07	.11	.15	.07	.09	.16
May 1977	.16	.24	.07	.13	.17	.06	.07	.13
June 1977	.19	.30	.07	.12	.19	.08	.09	.13
July 1977	.18	.22	.07	.14	.17	.06	.08	.09
Aug. 1977	.09	.20	.06	.10	.13	.06	.06	.13
	Mid and tall grasses							
	Balsamscale	Brownseed paspalum	Crinkle-awn	Seacoast bluestem	Switchgrass	Tanglehead	Texas grass	Mean <sup>3</sup>
Sept. 1975	0.05	0.07	0.04	0.06	0.06	0.07	0.07	0.07
Oct. 1975	.06	.09	.05	.05	.05	.03	.03	.07
Nov. 1975	.07	.09	.05	.04	.06	.06	.06	.07
Dec. 1975	.07	.09	.04	.03	.06	.05	.05	.06
Jan. 1976	.06	.10	.05	.05	.04	.07	.07	.06
Feb. 1976	.07	.09	.05	.03	.05	.08	.08	.07
Mar. 1976	.07	.09	.06	.05	.06	.06	.06	.07
Apr. 1976	.09	.12	.06	.06	.09	.07	.07	.09
May 1976	.06	.13	.06	.07	.09	.08	.08	.10
June 1976	.13	.18	.09	.10	.13	.10	.10	.13
July 1976	.07	.15	.07	.10	.12	.09	.09	.12
Aug. 1976	.09	.14	.08	.09	.10	.10	.10	.11
Sept. 1976	.06	.14	.07	.10	.10	.08	.12	.12

See footnotes at end of table.

Table 14. — Average magnesium content of grasses on the sandy range site on the 24 collection dates, percent by weight — Continued

Collection period	Short grasses							Mean <sup>3</sup>
	Balsamscale	Brownseed paspalum	Crinkle-awn	Seacoast bluestem	Switchgrass	Tanglehead	Texas grass	
Oct. 1976	0.10	0.12	0.08	0.09	0.13	0.08	0.12	0.11
Nov. 1976	.10	.10	.06	.10	.07	.10	.09	.09
Dec. 1976	.07	.09	.06	.07	.06	.06	.08	.08
Jan. 1977	.05	.09	.05	.03	.07	.06	.08	.06
Feb. 1977	.06	.11	.04	.06	.08	.05	.10	.08
Mar. 1977	.10	.19	.07	.06	.07	.06	.10	.11
Apr. 1977	.11	.18	.11	.08	.19	.15	.13	.13
May 1977	.12	.20	.08	.07	.16	.11	.17	.13
June 1977	.08	.19	.08	.09	.14	.13	.14	.13
July 1977	.06	.21	.06	.06	.14	.09	.11	.12
Aug. 1977	.10	.21	.06	.08	.10	.07	.10	.10
1975-76 mean .....								.08
1976-77 mean .....								.10

<sup>1</sup> Insufficient plant development for sampling.

<sup>2</sup> Insufficient sample for analyses.

<sup>3</sup> Mean for all 15 grasses.

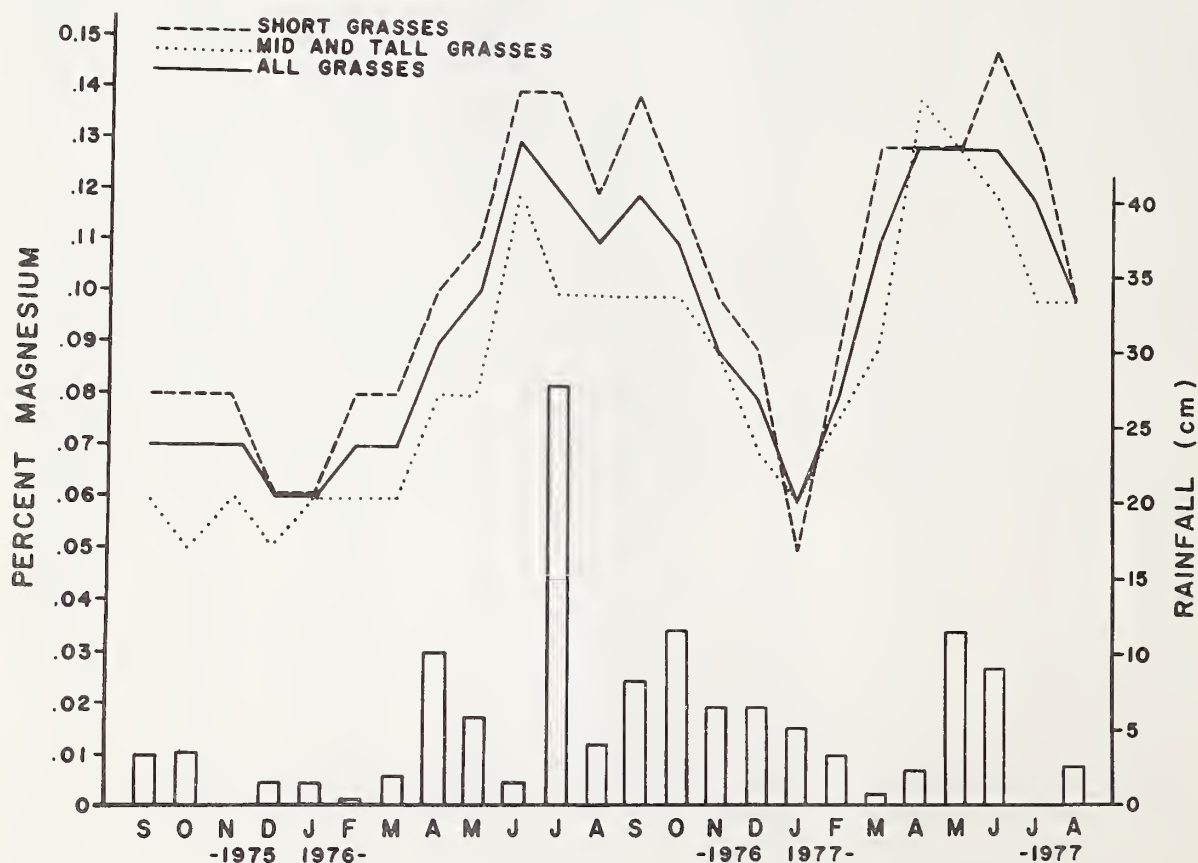


FIGURE 10. — Average magnesium content of grasses on the sandy range site.

Table 15. — Average magnesium content of grasses on the red sandy loam range site on the 24 collection dates, percent by weight

Collection period	Fringed signalgrass	Hooded windmillgrass	Red lovegrass	Roemer threeawn	Sandbur	Slender grama	Mean
Sept. 1975	0.11	0.06	0.06	0.06	0.11	0.08	0.08
Oct. 1975	.10	.06	.06	.05	.12	.07	.08
Nov. 1975	.10	.09	.07	.05	.12	.07	.08
Dec. 1975	.11	.06	.06	.04	.11	.06	.07
Jan. 1976	.09	.05	.05	.04	.09	.05	.06
Feb. 1976	.11	.05	.06	.04	.14	.05	.08
Mar. 1976	.08	.06	.06	.04	.08	.05	.06
Apr. 1976	.12	.08	.05	.04	.10	.05	.07
May 1976	.18	.12	.11	.09	.15	.10	.13
June 1976	.18	.11	.09	.08	.16	.09	.12
July 1976	.19	.10	.10	.09	.13	.07	.11
Aug. 1976	.21	.10	.10	.08	.17	.09	.11
Sept. 1976	.17	.12	.06	.10	.19	.10	.12
Oct. 1976	.14	.09	.07	.06	.12	.09	.10
Nov. 1976	.12	.09	.07	.06	.17	.08	.10
Dec. 1976	.18	.10	.07	.06	.12	.08	.10
Jan. 1977	.13	.07	.06	.05	.08	.05	.07
Feb. 1977	.17	.10	.09	.07	.11	.07	.10
Mar. 1977	.20	.10	.09	.07	.18	.10	.12
Apr. 1977	.19	.11	.08	.09	.21	.11	.13
May 1977	.20	.11	.09	.08	.17	.09	.12
June 1977	.20	.13	.09	.07	.13	.10	.12
July 1977	.21	.12	.07	.08	.14	.11	.12
Aug. 1977	.12	.11	.08	.06	.12	.07	.09
1975-76 mean							.09
1976-77 mean							.11

tall grasses (fig. 10). Magnesium levels were generally highest during summer and lowest in winter. Although Mg content remained relatively stable throughout both summers, it declined slightly in August 1977 following an extended period of hot, dry weather. Magnesium levels were slightly higher during the wet fall of 1976 than during the drier fall of 1975.

On the red sandy loam site, fringed signalgrass and sandbur had significantly higher levels of Mg than other species (table 8). Variances between the 2 years and among the collection dates were significant (table 15). Magnesium levels showed the same seasonal trends (fig. 11) as the sandy-site grasses (fig. 10).

The dry-cow Mg requirement has not been specifically determined but ranges from 0.04% to 0.10% of the dry ration; that for lactating cows is 0.18%. All grasses from both sites probably contained adequate levels of Mg for dry cows throughout the year, but since Mg levels of most grasses from both sites were considerably below the recommended requirement for lactating cows, we recom-

mend Mg supplementation throughout the year on both sites to avoid possible deficiency.

## SODIUM

Over the 2-year study period on the sandy range site, hooded windmillgrass had a significantly higher Na content than the other species, and tanglehead had significantly lower (table 6). Variance was significant between the 2 years and among the collection dates (table 16). There was significant month-species interaction, caused in part by wide variation in the Na content of several species on different collection dates. Short grasses were higher in Na than mid and tall grasses (fig. 12). Sodium levels were highest in July 1976 following an extended wet period. With the exception of this wet period, Na levels were highest in April when grasses were beginning growth and lowest in late fall and winter when grasses were dormant.

On the red sandy loam site the mean 2-year Na levels ranged from 0.03% in fringed signalgrass and

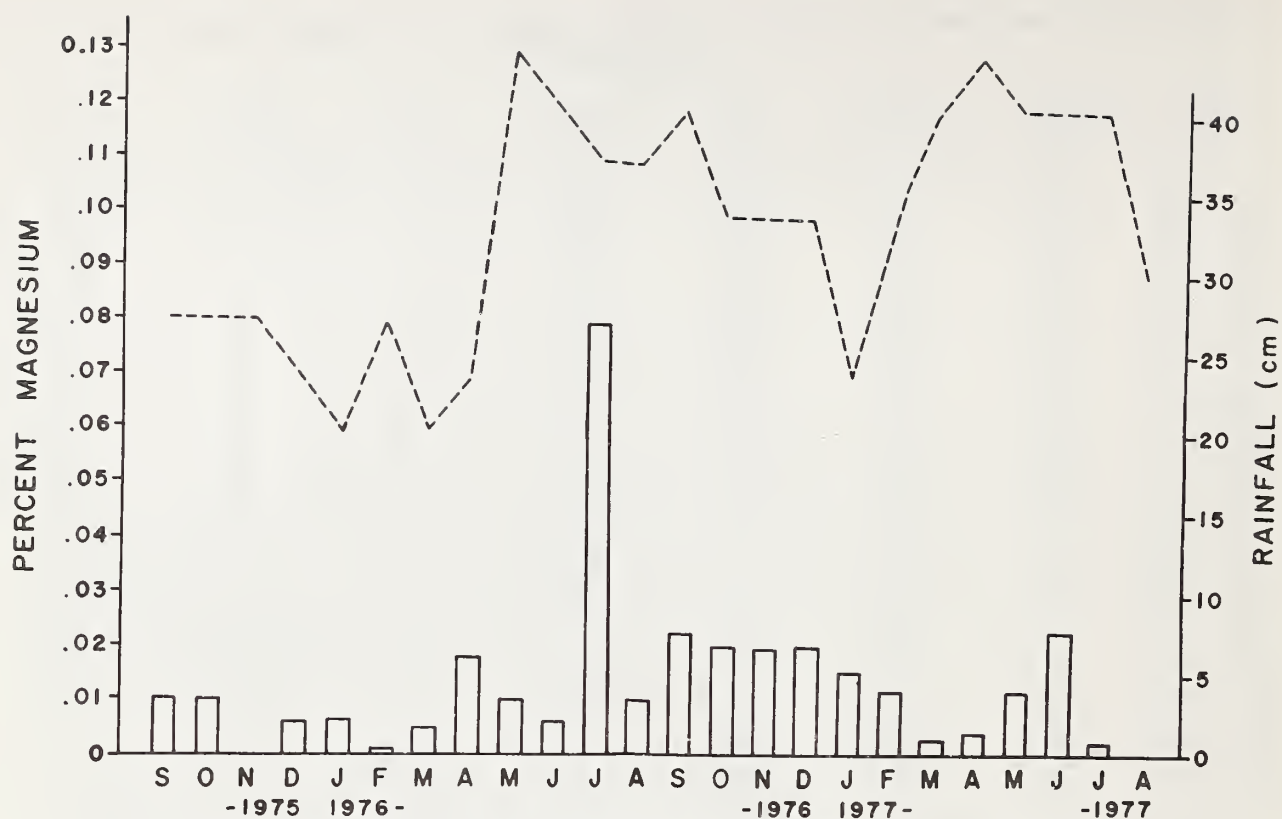


FIGURE 11. — Average magnesium content of grasses on the red sandy loam range site.

Table 16. — Average sodium content of grasses on the sandy range site on the 24 collection dates, percent by weight

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Sept. 1975	0.02	0.07	0.02	0.06	0.08	0.04	0.02	0.13
Oct. 1975	.02	.11	.02	.02	.04	.04	.02	.02
Nov. 1975	.02	.05	.04	.10	.06	.07	.03	.08
Dec. 1975	.02	(1)	.02	.07	.04	.05	.02	.05
Jan. 1976	(1)	(1)	.02	.10	.03	.04	.02	.04
Feb. 1976	.02	.12	.03	.08	.05	.06	.05	.06
Mar. 1976	.03	.13	.03	.09	.05	.08	.04	.05
Apr. 1976	.08	.26	.10	.20	.13	.13	.06	.24
May 1976	.10	.20	.10	.18	.11	.14	.05	.22
June 1976	.08	.19	.10	.15	.15	.15	.09	.26
July 1976	.12	.20	.10	.39	.28	.14	.11	.21
Aug. 1976	.04	.21	.08	.34	.10	.09	.04	.16
Sept. 1976	.03	.09	.02	.11	.12	.07	.02	.11
Oct. 1976	.02	.08	.03	.12	.08	.06	.02	.08
Nov. 1976	.03	.06	.02	.05	.06	.07	.02	.08
Dec. 1976	.03	.03	.02	.13	.05	.03	.02	.05
Jan. 1977	.02	(1)	.02	.04	.02	.02	.02	(2)
Feb. 1977	.03	.09	.03	.11	.04	.03	.02	.04
Mar. 1977	.03	.12	.04	.37	.11	.05	.06	.05

See footnotes at end of table.

Table 16. — Average sodium content of grasses on the sandy range site on the 24 collection dates, percent by weight — Continued

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Apr. 1977	0.04	0.12	0.10	0.27	0.12	0.07	0.05	0.24
May 1977	.04	.11	.02	.13	.10	.06	.05	.12
June 1977	.06	.10	.03	.15	.10	.08	.07	.20
July 1977	.05	.11	.03	.14	.13	.06	.06	.22
Aug. 1977	.03	.06	.02	.13	.06	.08	.03	.12
	Mid and tall grasses							
	Balsamscale	Brownseed paspalum	Crinkle-awn	Seacoast bluestem	Switchgrass	Tanglehead	Texas grass	Mean <sup>3</sup>
Sept. 1975	0.02	0.02	0.06	0.09	0.04	0.02	0.04	0.05
Oct. 1975	.02	.03	.01	.02	.09	.02	.03	.03
Nov. 1975	.02	.10	.02	.03	.08	.03	.05	.05
Dec. 1975	.02	.04	.02	.02	.05	.02	.04	.03
Jan. 1976	.03	.04	.02	.02	.06	.02	.05	.04
Feb. 1976	.06	.06	.03	.03	.06	.03	.05	.05
Mar. 1976	.02	.05	.04	.03	.05	.04	.05	.05
Apr. 1976	.08	.07	.10	.08	.11	.08	.16	.13
May 1976	.02	.02	.03	.02	.05	.02	.06	.09
June 1976	.04	.10	.04	.08	.15	.03	.11	.11
July 1976	.08	.05	.09	.07	.16	.09	.10	.15
Aug. 1976	.11	.07	.02	.04	.06	.03	.06	.10
Sept. 1976	.02	.02	.02	.03	.05	.02	.06	.05
Oct. 1976	.03	.03	.03	.03	.06	.06	.05	.05
Nov. 1976	.03	.04	.02	.03	.05	.03	.05	.04
Dec. 1976	.02	.02	.02	.03	.04	.02	.04	.04
Jan. 1977	.02	.02	.02	.02	.03	.01	.03	.02
Feb. 1977	.02	.02	.04	.02	.03	.02	.05	.04
Mar. 1977	.03	.02	.03	.03	.04	.04	.06	.07
Apr. 1977	.06	.02	.03	.02	.09	.02	.20	.10
May 1977	.03	.03	.03	.02	.11	.01	.10	.06
June 1977	.03	.02	.04	.03	.09	.03	.07	.07
July 1977	.03	.03	.03	.02	.05	.02	.07	.07
Aug. 1977	.06	.05	.02	.06	.08	.02	.06	.06
1975-76 mean								.08
1976-77 mean								.06

<sup>1</sup> Insufficient plant development for sampling.

<sup>2</sup> Insufficient sample for analyses.

<sup>3</sup> Mean for all 15 grasses.

slender grama to 0.07% in hooded windmillgrass and sandbur. Sodium levels differed significantly among the six species. Variances among the different collection dates were significant (table 17), but no significant difference was found between the 2 years. Again, the highest Na levels occurred in July 1976 after the excessively wet period, and Na levels had a similar increase following a rainfall peak in June 1977 (fig. 13). In both years, Na levels were lowest in January.

The Na requirement for both dry and lactating cows is 0.06%. Sodium levels were generally adequate in the spring and summer of both years on the sandy site but inadequate throughout the year in grasses from the red sandy loam site except after periods of high rainfall during the growing season. Livestock grazing a red sandy loam site would probably need Na supplementation throughout the year; those grazing a sandy site would  
(Continued on page 28.)

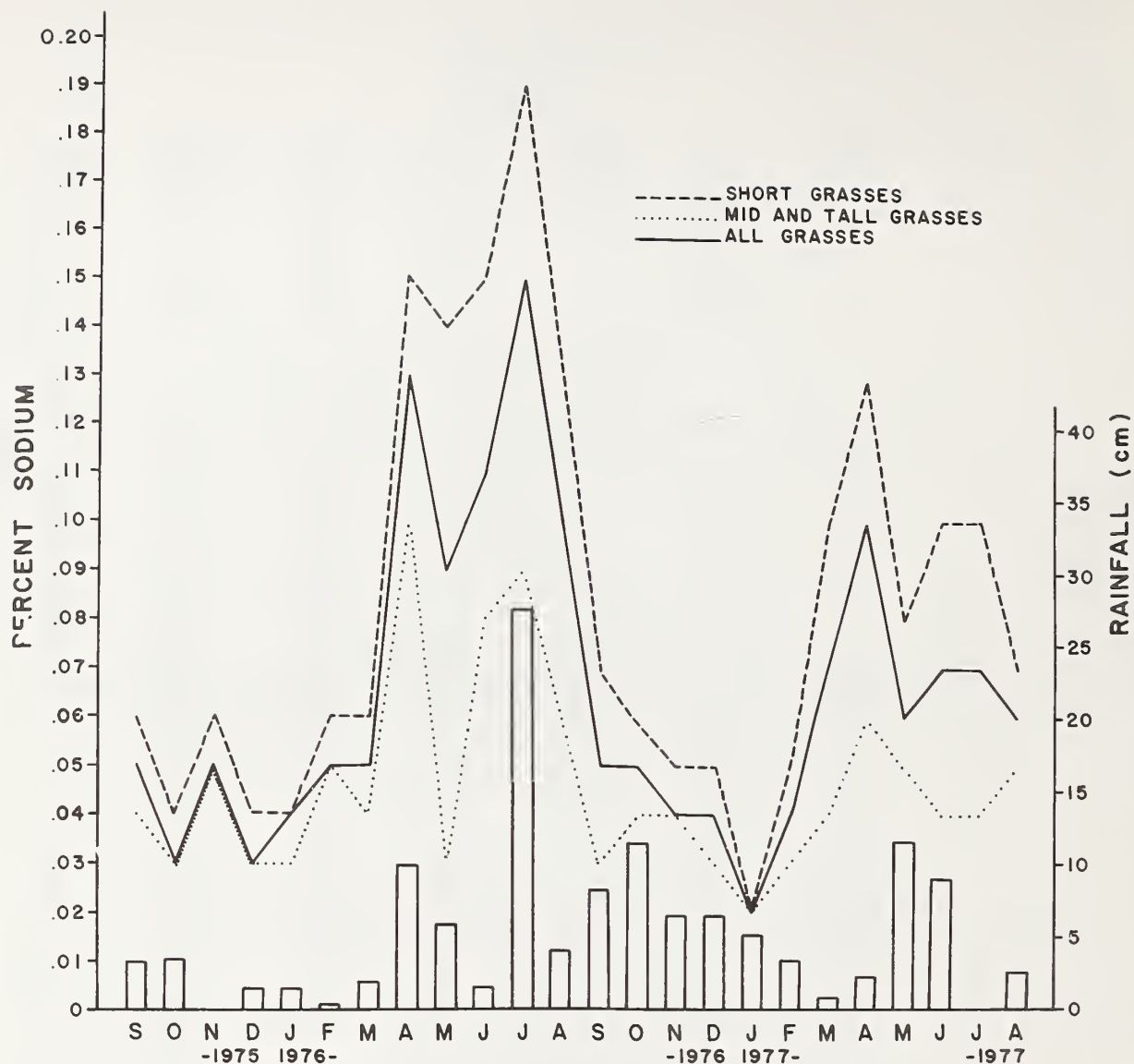


FIGURE 12. — Average sodium content of grasses on the sandy range site.

Table 17. — Average sodium content of grasses on the red sandy loam range site on the 24 collection dates, percent by weight

Collection period	Fringed signalgrass	Hooded windmillgrass	Red lovegrass	Roemer threeawn	Sandbur	Slender grama	Mean
Sept. 1975	0.03	0.13	0.13	0.08	0.08	0.02	0.08
Oct. 1975	.02	.07	.04	.02	.06	.02	.04
Nov. 1975	.02	.10	.05	.02	.08	.02	.05
Dec. 1975	.03	.03	.03	.03	.03	.03	.03
Jan. 1976	.01	.03	.02	.02	.02	.02	.02
Feb. 1976	.02	.08	.05	.02	.03	.05	.04
Mar. 1976	.03	.05	.03	.04	.03	.02	.03
Apr. 1976	.03	.05	.03	.03	.03	.02	.03

Table 17. — Average sodium content of grasses on the red sandy loam range site on the 24 collection dates, percent by weight — Continued

Collection period	Fringed signalgrass	Hooded windmillgrass	Red lovegrass	Roemer threeawn	Sandbur	Slender grama	Mean
May 1976	0.03	0.05	0.05	0.04	0.06	0.03	0.04
June 1976	.02	.06	.05	.05	.05	.02	.04
July 1976	.08	.15	.10	.12	.12	.08	.11
Aug. 1976	.03	.07	.05	.04	.04	.02	.04
Sept. 1976	.03	.07	.07	.03	.12	.03	.06
Oct. 1976	.03	.06	.04	.02	.06	.03	.04
Nov. 1976	.03	.05	.04	.03	.06	.02	.04
Dec. 1976	.03	.06	.05	.03	.04	.02	.04
Jan. 1977	.03	.04	.03	.03	.03	.02	.03
Feb. 1977	.03	.05	.04	.05	.04	.02	.04
Mar. 1977	.03	.06	.05	.04	.06	.02	.04
Apr. 1977	.02	.10	.04	.03	.13	.02	.06
May 1977	.04	.07	.05	.05	.08	.03	.05
June 1977	.05	.08	.05	.05	.19	.03	.08
July 1977	.03	.08	.04	.04	.13	.03	.06
Aug. 1977	.03	.06	.03	.06	.10	.02	.05
1975-76 mean							.05
1976-77 mean							.05

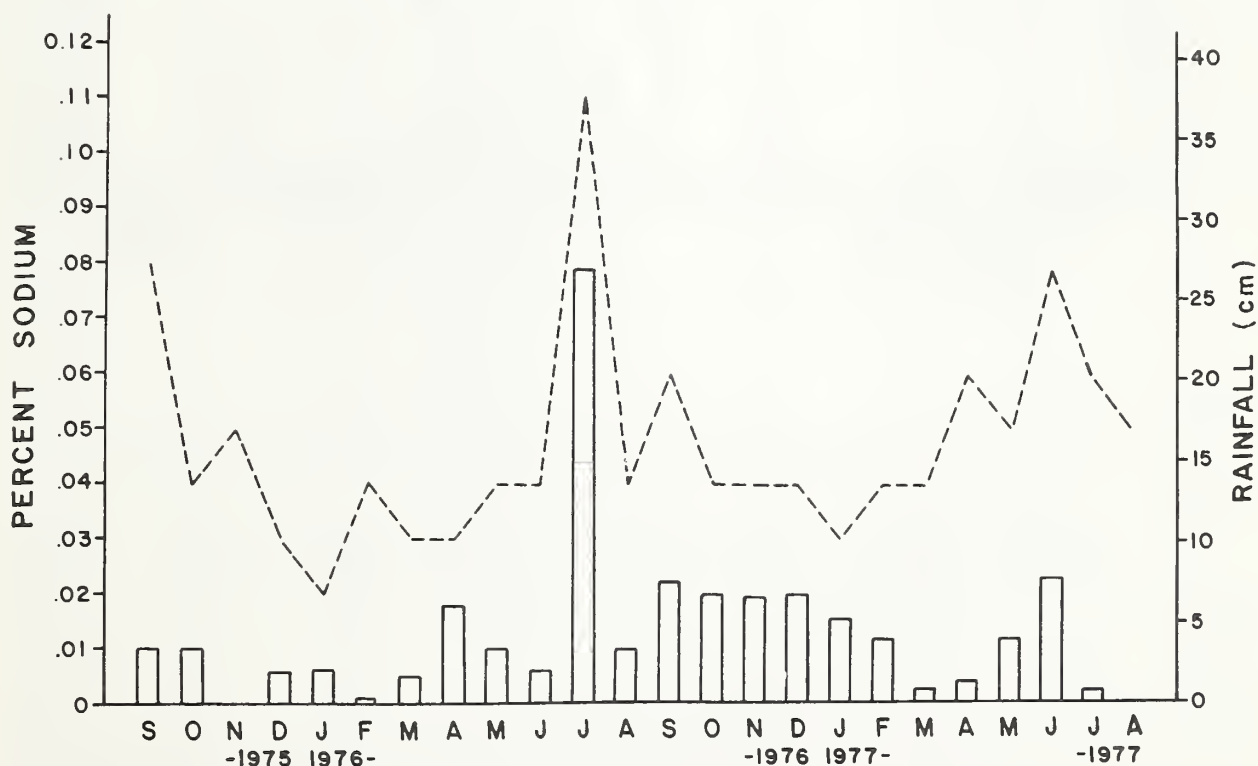


FIGURE 13. — Average sodium content of grasses on the red sandy loam range site.

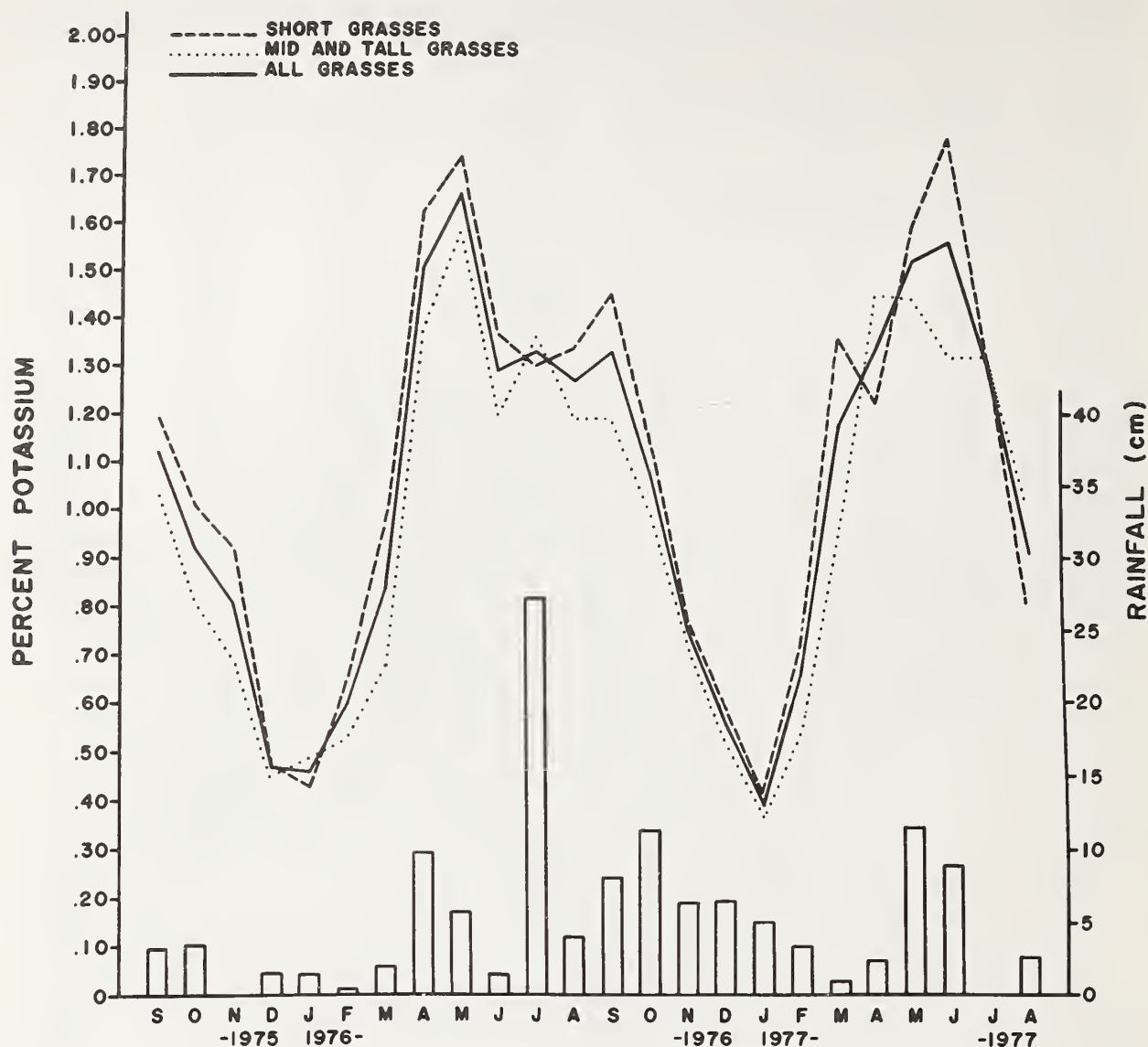


FIGURE 14. — Average potassium content of grasses on the sandy range site.

Table 18. — Average potassium content of grasses on the sandy range site on the 24 collection dates, percent by weight

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Sept. 1975	1.41	1.85	0.63	1.56	1.06	0.93	0.59	1.47
Oct. 1975	1.23	1.20	.57	1.14	1.11	1.01	.43	1.38
Nov. 1975	1.30	1.29	.47	1.25	.61	.79	.43	1.24
Dec. 1975	1.07	( <sup>1</sup> )	.40	.61	.25	.40	.29	.37
Jan. 1976	( <sup>1</sup> )	( <sup>1</sup> )	.38	.84	.35	.34	.29	.36
Feb. 1976	.98	1.01	.43	1.05	.54	.57	.25	.43

See footnotes at end of table.

Table 18. — Average potassium content of grasses on the sandy range site on the 24 collection dates, percent by weight — Continued

Collection period	Short grasses							
	Fringed signalgrass	Fringeleaf paspalum	Hairy grama	Hooded windmillgrass	Knotgrass	Red lovegrass	Roemer threeawn	Sandbur
Mar. 1976	1.31	2.19	0.55	1.55	0.64	0.53	0.51	0.57
Apr. 1976	2.46	2.57	.59	1.81	1.62	1.32	.61	2.25
May 1976	2.30	1.78	.81	2.32	2.08	1.27	.75	2.60
June 1976	1.65	1.67	.64	2.50	1.31	.88	.64	1.68
July 1976	1.51	2.00	.70	1.97	1.21	.95	.63	1.46
Aug. 1976	1.53	1.85	.75	1.76	1.28	.88	.63	2.06
Sept. 1976	1.52	2.30	.74	2.18	1.39	.65	.71	2.09
Oct. 1976	1.34	1.33	.66	1.60	1.07	.85	.55	1.68
Nov. 1976	.80	.73	.54	.82	.73	.66	.52	1.35
Dec. 1976	.70	.48	.32	1.24	.48	.51	.47	.53
Jan. 1977	.56	( <sup>1</sup> )	.33	.74	.29	.29	.27	( <sup>2</sup> )
Feb. 1977	.84	2.00	.52	1.03	.56	.30	.29	.48
Mar. 1977	2.04	2.40	.52	1.48	2.27	.35	.69	1.14
Apr. 1977	1.50	1.65	.62	1.21	1.33	1.05	.90	1.53
May 1977	1.68	2.21	.82	1.88	2.05	.88	.63	2.57
June 1977	2.10	3.12	.88	1.44	2.07	1.11	.62	2.87
July 1977	1.65	2.03	.68	2.27	1.09	.86	.67	1.29
Aug. 1977	.73	1.04	.55	1.06	.80	.56	.49	1.06
Mid and tall grasses								
	Balsamscale	Brownseed paspalum	Crinkle-awn	Seacoast bluestem	Switchgrass	Tanglehead	Texas grass	Mean <sup>3</sup>
Sept. 1975	0.89	1.36	0.86	0.80	0.84	1.11	1.40	1.12
Oct. 1975	.86	1.07	.89	.47	.98	.66	.75	.92
Nov. 1975	.88	1.15	.52	.48	.62	.64	.53	.81
Dec. 1975	.50	.50	.38	.34	.60	.45	.35	.47
Jan. 1976	.55	.46	.44	.36	.70	.42	.52	.46
Feb. 1976	.72	.51	.46	.38	.50	.50	.62	.60
Mar. 1976	.79	.82	.72	.63	.64	.53	.62	.84
Apr. 1976	1.50	1.51	.97	1.24	1.65	1.15	1.49	1.50
May 1976	1.60	1.55	1.21	1.79	1.73	1.25	1.91	1.66
June 1976	1.35	1.49	1.02	.91	1.63	.98	1.00	1.29
July 1976	1.37	1.54	1.24	1.25	1.32	1.30	1.51	1.33
Aug. 1976	1.11	1.68	.97	1.08	1.10	1.15	1.25	1.27
Sept. 1976	1.20	1.10	.99	1.03	1.26	.99	1.75	1.33
Oct. 1976	1.06	1.07	.97	.76	.78	.93	1.34	1.07
Nov. 1976	.75	.71	.59	.72	.81	.77	.70	.75
Dec. 1976	.52	.51	.48	.51	.52	.48	.63	.56
Jan. 1977	.30	.27	.28	.30	.63	.32	.50	.39
Feb. 1977	.58	.29	.28	.72	.84	.30	.83	.66
Mar. 1977	.97	1.50	.61	.64	.94	.30	1.71	1.17
Apr. 1977	1.73	1.17	1.02	1.05	2.30	1.15	1.72	1.33
May 1977	1.43	1.77	.96	1.18	1.49	1.31	1.97	1.52
June 1977	1.13	1.22	1.02	1.27	1.18	1.45	1.95	1.56
July 1977	1.27	1.40	1.13	1.03	1.08	1.22	2.08	1.32
Aug. 1977	.99	1.02	.71	.97	.99	1.09	1.35	.91
1975-76 mean								1.04
1976-77 mean								1.06

<sup>1</sup> Insufficient plant development for sampling.

<sup>2</sup> Insufficient sample for analyses.

<sup>3</sup> Mean for all 15 grasses.

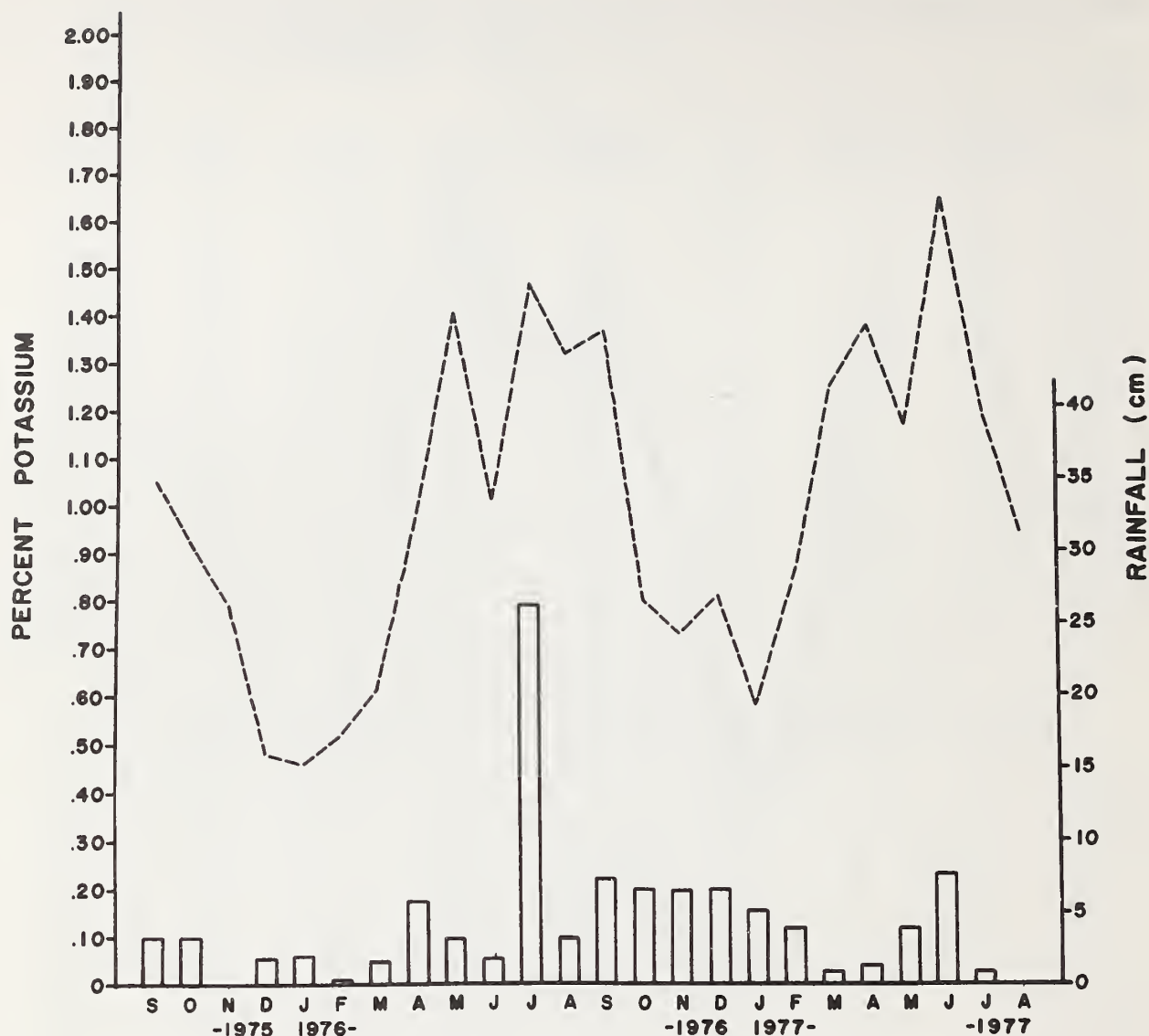


FIGURE 15. — Average potassium content of grasses on the red sandy loam range site.

need it during fall and winter. The Na content of livestock drinking water may help supplement Na, but we recommend providing livestock on either site with common salt throughout the year to prevent Na deficiency.

#### POTASSIUM

The K content of sandy-site grasses ranged from 0.54% for Roemer threeawn to 1.68% for fringed leaf paspalum (table 6). Fringed leaf paspalum contained significantly higher levels of K than other species. Significant differences were found

among collection dates, and a significant month-species interaction was observed (table 18). Potassium levels were generally higher for short grasses than for the mid and tall grasses (fig. 14). Potassium levels were generally lowest in winter and highest in the spring or early summer when rainfall was ample and the grasses were just beginning growth.

On the red sandy loam site, K levels ranged from 0.62% for Roemer threeawn to 1.37% for sandbur (table 8). There was significant variance between the two study years and among collection dates (table 19). Seasonal trends in K levels (fig. 15) were similar to those shown by grasses on the

Table 19. — Average potassium content of grasses on the red sandy loam range site on the 24 collection dates, percent by weight

Collection period	Fringed signalgrass	Hooded windmillgrass	Red lovegrass	Roemer threeawn	Sandbur	Slender grama	Mean
Sept. 1975	1.31	1.28	0.88	0.60	1.58	0.63	1.05
Oct. 1975	1.09	1.29	.68	.48	1.36	.53	.91
Nov. 1975	.89	1.16	.77	.38	1.04	.51	.79
Dec. 1975	.59	.54	.51	.40	.48	.36	.48
Jan. 1976	.53	.52	.50	.40	.42	.39	.46
Feb. 1976	.80	.43	.52	.36	.65	.35	.52
Mar. 1976	.57	.86	.89	.42	.53	.45	.62
Apr. 1976	2.20	1.08	.96	.47	.53	.59	.97
May 1976	1.98	1.30	1.42	.82	2.12	.76	1.40
June 1976	1.27	1.17	.86	.62	1.56	.57	1.01
July 1976	1.70	1.76	1.25	.79	2.52	.76	1.46
Aug. 1976	1.83	.96	1.14	.74	2.50	.71	1.31
Sept. 1976	1.60	1.42	1.32	.67	2.32	.85	1.36
Oct. 1976	.82	.81	.76	.61	1.12	.65	.80
Nov. 1976	.64	.38	.71	.59	1.02	.51	.73
Dec. 1976	1.13	1.04	.71	.53	.89	.55	.81
Jan. 1977	1.38	.59	.46	.47	.28	.31	.58
Feb. 1977	1.33	1.04	.79	.77	.63	.57	.86
Mar. 1977	1.86	1.11	1.19	.82	1.65	.82	1.24
Apr. 1977	1.60	1.59	1.12	.89	2.09	.91	1.37
May 1977	1.48	1.07	1.02	.71	1.85	.85	1.16
June 1977	1.90	2.05	1.33	.82	2.49	1.25	1.64
July 1977	1.47	1.40	.91	.77	1.60	1.03	1.20
Aug. 1977	.97	1.10	.63	.55	1.67	.70	.94
1975-76 mean							.92
1976-77 mean							1.06

sandy site (fig. 14), except that during the wet summer of 1976, K levels remained as high as during the spring. Potassium levels were also considerably higher during the wet fall and winter of 1976-77 than during the drier fall and winter of 1975-76.

The K requirement for beef cattle has not been specifically determined, but ranges from 0.60% to 0.80% of the dry ration; the K requirements of dry and lactating cows do not differ. Most grasses were deficient in K from December through February or early March when initial spring growth resumed (figs. 14 and 15). We recommend K supplementation during winter, since K deficiency is more pronounced then (especially if the winter is dry).

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